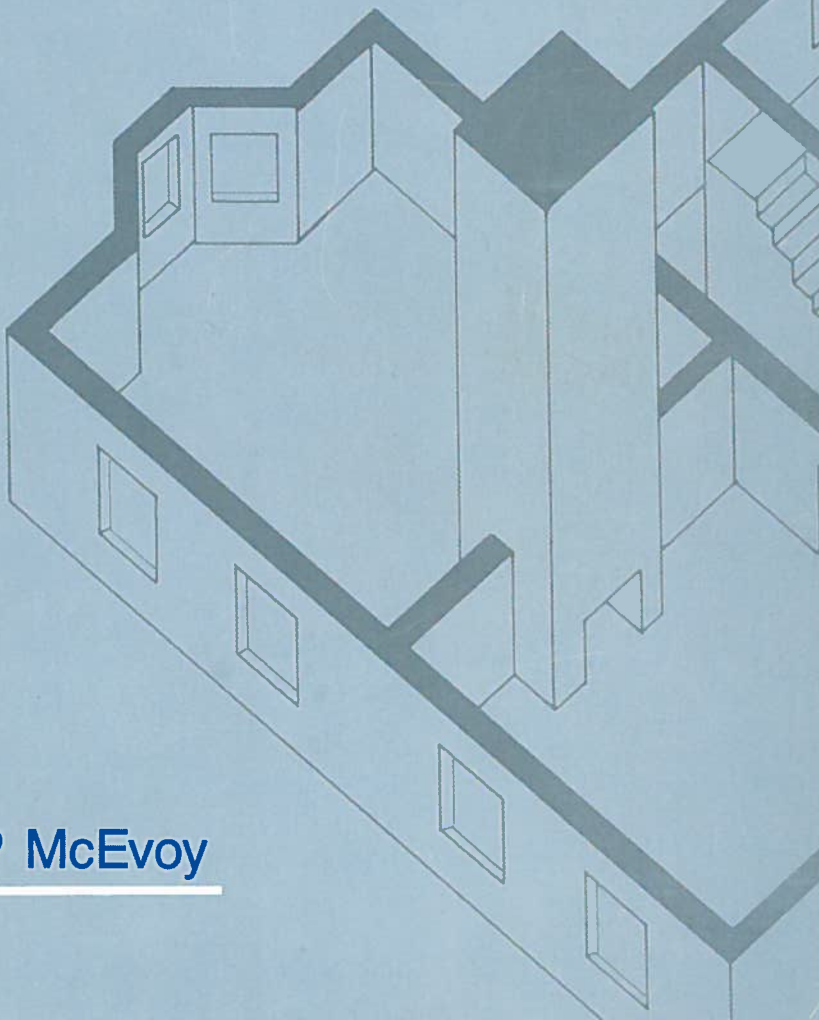
READING THE BUILDING CODE

A Short Hermeneutic



Joseph P. McEvoy

Reading the Building Code

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Being a guide through the labyrinth for policy makers, public officials, design professionals, property managers, students of government, construction personnel, and anyone who has ever wondered what a building code is about.

Northeastern University
Office of the Custom Textbook Program

MANUFACTURED IN THE UNITED STATES OF AMERICA

For Moira & Kate

Contents

Acknowledgments

This book, like the building code, has many authors. A small army of architects, bureaucrats, carpenters, developers, engineers, firemen, lawyers, politicians, realtors, and so forth have contributed to these pages. Because the core technology of the inspector's profession involves listening to (and evaluating) *explanations* it would be impossible for me to give credit to all those who have helped me to understand the manifold aspects of the built environment. There are some, however, who through a special investment of time and effort, in the form of encouragement, argument, suggestions, and criticism, have participated in the composition of this volume.

Attorney William Donahue, chairman of the health care section of the Massachusetts Bar Association, is the only person who has read this manuscript, in its successive incarnations, more often than I have. His patient tutoring in the legal concepts of liability, tort, and risk has been essential in this undertaking. Dr. Robert Fitzgerald of Worcester Polytechnic Institute is responsible for my enduring fascination with the science of structures and the relatively infant field of fire safety engineering. Chris Hopey, director of Northeastern University's Center for Building and Construction Technology saw the possibilities in this project when I had despaired of them. Frank Tedesco of the Mount Vernon Group Architects and Planners of Winchester, Massachusetts, gave me not only encouragement and advice, but an opportunity to work with a talented group of designers in the years during which this volume was written. Peter Goodale of the Massachusetts Department of Public Safety not only provided valuable guidance, but fed me, sheltered me, took me sailing when necessary, and kept my sense of humor afloat. Paul Piepiora, also of the Massachusetts Department of Public Safety, has provided vigilant and insightful criticism and many valuable suggestions. Massachusetts State Building Inspectors Jim Barry, Novello Giovonni, and Arthur Ritacco kept me supplied with an endless stream of puzzling questions. Massachusetts State Senator Thomas White, chairman of the Joint Committee on Public Safety, has for nearly twenty years helped me to decipher the arcane workings of the legislative apparatus on Beacon Hill. Town Councilors Scott Lazo and David Smick of Southbridge, Massachusetts, supplied me with vigorous and challenging debate, usually over pitchers of Rolling Rock at the Copper Penny Pub. Gus Stathis of the physical plant department at Boston University provided me with a plethora of practical problems, both legal and technical, to solve. The unabating faith of Richard Fredette, of Fredette Electric, kept me inspired and served to flagellate me toward completion. Dr. Bernie Kaplan of Clark

University has helped me to appreciate that interpretation is an ancient and inexorable art that has existed for as long as people have been expressing themselves. Jill Bahcall of Northeastern University Custom Book Program combined an infirm command of building technology with a ear for language that has served to make this volume as readable as it has become. Her work was augmented by Margaret Anne Jasinski, a graduate student at Worcester State College, who applied her Canadian standards of grammar and syntax to my American prose. Finally, the wrinkled brows of my students at Northeastern University have forced me to aspire to a level of clarity beyond my usual abilities.

To these people and many others belong the primary responsibility for any merit in this project. Needless to say, any errors, of commission, omission, submission, or emission, I claim as my very own.

Joseph P. McEvoy
Worcester, Massachusetts
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Introduction

We spend the better part of our lives within what the more metaphysical subspecialties of the field of architecture call "the built environment." How this environment is built affects our lives in many ways, some of them quite subtle. Our comfort, our moods, our aesthetic sense, our safety, and our health are all influenced by our choices, whether intentional or otherwise, in the design of our built environments.

To those uninitiated in the rituals of architectural practice, the design of a building or structure may seem to be an unfettered expression of the architect's creative powers. Nothing could be further from the truth. The extent to which legal rules and regulations impose upon the private decisions of the design professional is considerable, and there are those who have begun to recognize that the mind-bludgeoning monotony of our architecture is, in some measure, a consequence of this imposition.

The constraints upon the design process are expressed in law. The Constitution of the United States of America expressly and unequivocally limits the extent to which the polity is entitled to confine private decisions. It has been widely accepted, however, that issues affecting the health and safety of the public are sufficiently compelling to cause us to limit our freedoms.

The following chapters contain a study of a document that exemplifies such a system of rules and regulations. It is a document of many ironies. It was written by many authors, many of whom are anonymous. It is purchased and used by a wide variety of people, few of whom have read it in its entirety. It sells an impressive number of copies each year but has never been listed as a "best-seller." It carries the force of law but its binding is made by convicted felons, and though it weighs slightly more than three pounds, it is regarded by many to be the heaviest of burdens. Although the code's purpose is to protect the safety and health of the population, it has been known to ulcerate the digestive tracts of many who attempt to penetrate its secrets.

The building code of the Commonwealth of Massachusetts is primarily a legal document. But it is also a technical and an historical document. It is required reading for a variety of professionals and governs a wide range of activities. It is a small part of a very large body of law known as the Code of Massachusetts Regulations, a compendium of social rules that occupies some 12 linear feet of shelf space at the office of the secretary of state.

The 2¼-inch thick portion known to the public as the Massashusetts State Building Code is known to law librarians as "780 CMR: articles 1

through 22 with appendices." It was originally promulgated under the authority of chapter 802 of the acts of 1972 and became effective for the first time on January 1, 1975. This edition was substantially revised four times during the next five years, emerging in the form in which it enjoyed its longest tenure on September 1, 1980. The most recent version of the fourth edition emerged on May 1, 1990.

Hermeneutics is an approach within the fields of philosophy and theology which is concerned with interpretation of texts. The word is derived from the name of Hermes Trismegistus and is associated with the secret writings of the Gnostics of the first three centuries A.D. It would be something of an exaggeration to describe the building code as a "secret writing." But, a document with such a wide range of authors, audiences, purposes, and topics can be expected to have obscurities, areas of confusion, arcane legalisms, and scientific jargon, "concealing itself" as J.S. Furnivall once said of the British colonial office, "like a cuttlefish in a cloud of ink."

This manual was written to assist the novice in penetrating the "cloud of ink" and to facilitate an understanding of both the letter and the spirit of the code. It is intended that with some discussion of the structure, function, rationale, and history of the document, much of the bewildering complexity of its language will be dissipated. It is further intended that the resulting clarity will have a liberating effect. A critical understanding of the texts that increasingly regulate our lives is essential for preserving the freedom of expression that is an essential feature of our American heritage and to which, as American citizens, we are entitled.

1

Authenticity, Authority, and Authorship

"Anyone who enjoys sausage or respects the law should never seek to learn how either is made."

—Senator Robert Taft

AUTHENTICITY

Building codes are not recent innovations. They have existed, in one form or another, since antiquity. The oldest example known is from the code of Hammurabi, which was the law of the land of Babylon nearly four thousand years ago. By contemporary standards, it was concise, clear, and easy to enforce. Using the concept known as criminal negligence in contemporary jurisprudence, the code stated simply that if a building failed, injuring the occupant, the architect would be put to death. There was, additionally, something of a "warranty provision" extending the liability for a generation, so the son of the architect could be executed as a consequence of building failure. By contrast, the contemporary building code is voluminous, wordy, and technically complex but considerably gentler in its treatment of the architect.

Modern building codes are intended to manage a variety of hazards inherent in the built environment. As in the time of Hammurabi, the structural stability of buildings is a primary concern. Until about a century ago structural principles were an aggregate of "rules of thumb" which the architect used to estimate the proper proportions of supporting elements to the overall dimensions of the building. For small-scale buildings, rules such as sizing the depth of a beam to one tenth of its span or supporting a beam at each third of its length, proved reasonably serviceable, but for structures whose dimensions were ambitious, this method was not without incident.

In the nineteenth century, engineering and materials science developed to the point where *loads* could be assumed and *properties of materials* analyzed. Vector mechanics were used to study the dynamics of failure, and with the computation of factors of safety, *minimum standards* for structural

strength and dimensioning of structural members, as well as standards for joining structural elements, were derived.

In the years since Hammurabi's rule, the need to place restrictions on the design of buildings has forced regulators to address issues beyond the structural safety of the building. Since wood, owing to its abundance and workability, has always been a popular building material, the vulnerability of structures to damage by fire became a community concern especially in densely populated cities. In ancient Rome, following fires that destroyed large sections of the city, the "Corps of Vigiles" (the root of our contemporary term "vigilante") was established, granting local officials powers similar to those of our present-day fire marshall. In the eleventh and twelfth centuries A.D. formal regulation emerged in England, requiring construction in densely settled areas to be of stone. In the later centuries, English common law borrowed concepts of individual responsibility from the Napoleonic Code, which not only addressed the issues of personal liability but invoked the plenary and inherent powers of the community directly to compel measures to protect the safety of the public.

Some antecedents of contemporary fire safety regulation evolved in colonial America. The first recorded major fire of this era occurred in the first colony, Jamestown, in 1608, marking the end to this settlement. The pilgrims landed at Plymouth in 1620, and it took merely six years before these seekers after freedom instituted restrictions on building. With an increasing density of housing and the consequent risk of fire, thatched roofs were outlawed in 1626. In New Amsterdam the year 1648 saw the prohibition of wooden and plaster chimneys. Following the conflagration in Charlestown in 1740, new buildings were required to be of noncombustible construction. With the establishment of "fire zone" districts in Boston in 1890, an antecedent of contemporary zoning methods was born.

Major conflagrations marked the development of many cities in the United States. In 1835 13 acres of New York City were leveled by fire. In 1845 approximately 1,000 buildings were destroyed in Pittsburgh. Portland, Maine, lost 1,500 buildings in 1866. In 1871 more than 17,000 buildings were destroyed by fire in the City of Chicago. San Francisco experienced conflagrations in 1851 and again immediately following the earthquake of 1906. More local examples include not only Charlestown but Chelsea, which experienced two major conflagrations: in 1872 776 buildings were lost, and in 1889 another 52 buildings were destroyed.

Preventive measures were thought to be necessary. A conflagration was a serious matter resulting not only in the loss of buildings but also in the loss of life. In the days before well-equipped fire services, readily available water supplies, and fire separation of buildings, a fire could devastate a community.

Eventually, in response to disasters, laws were passed, but the resulting

hodgepodge of statutes, regulations, ordinances, customs, and case law was too unwieldy to provide adequate protection for public safety. Laws were unenforced, misenforced, ill enforced, and otherwise ineffective and sometimes proved to be affirmatively harmful. Beyond this there was the problem of a developing technology that was advancing with a rapidity that could not be matched by the glacially slow and cumbersome machinations of state and local legislatures.

Giving credit where credit is due, we must appreciate that the measures introduced during these years were successful in reducing the scale of fires. Conflagrations began to decrease in size from the city scale, to the neighborhood scale, to the block scale, and eventually most fires were contained to a single building lot. But even within the confines of a single lot, the number of deaths in some fires could be enormous. In 1940 a fire in the Rhythm Club in Natchez, Mississippi, claimed the lives of 207 people; 492 people died in the Cocoanut Grove Restaurant in Boston in 1942; in 1958 95 people were killed in Our Lady of the Angels Elementary School in Chicago. Consequently, we have seen in the last half century a concerted effort on the part of regulators to confine the spread of fire to within the building, that is, to the floor or the room of origin.

The latter focus was stimulated in part by the efforts of the model code groups. Since its inception in 1895, the National Fire Protection Association has contributed to efforts to ensure appropriate construction materials, adequate egress, and compartmentation of areas within buildings by developing model code provisions. These were first adopted by the Mutual Insurance companies as compliance standards to qualify for preferred risk insurance coverage. Eventually these standards were adopted, in whole or in part, into the language of municipal codes. Organizations such as the National Board of Fire Underwriters, the Southern Building Code Congress, the Council of American Building Officials, Building Officials and Code Administrators International, and the International Conference of Building Officials have contributed to the model code effort by incorporating many of the known principles of firesafe design into the general scheme of structural safety, height and area limitations, provisions for light and ventilation, and design of egress passageways.

Building codes throughout the United States have come to use the same fundamental regulatory strategy. This involves the classification of *construction types* and *occupancy groups*. The relative risk of each occupancy is contrasted with each construction type. For a given occupancy, each construction type is given a unique height and area limitation. This technique, which can be appreciated by studying Table 305 of the Massachusetts State Building Code (see pages 122–123), is used in every building code in the United States and is taking root in countries throughout the globe. A detailed discussion of these classifications is provided in chapter 4 of this book.

AUTHORITY

Where do the building codes come from? Who writes them? By what authority do the codes influence the design or construction of buildings? These are questions free people *should* and *do* ask.

A distinctive feature of public enterprise is that all activity is initiated, controlled, and concluded by law. It is the role of law that distinguishes the public sector from the private sector. Largely at the behest of the Home Builders Association, the Massashusetts legislature in the early 1970s began to consider the adoption of a state building code. At the time, each of the 351 cities and towns in Massachusetts was empowered to adopt its own code. This presented a problem for the construction industry. Using a set of blueprints that described an adequately designed building, a contractor could obtain a permit in Lexington, for example, but be denied a permit using the same set of blueprints a few miles away in Concord or Cambridge. The differences in the standards were oftentimes a matter of idiosyncratic wording in the codes and did not always reflect substantive issues of structural safety or firesafe design. The Home Builders Association and some other concerned parties petitioned the legislature to intervene, and the result was the passage of chapter 802 of the acts of 1972, entitled "An Act Establishing the State Building Code Commission for the Adoption and Promulgation of a State Building Code."

When an *act* is passed by the legislature and signed by the governor, it becomes what we call simply "a law." In most cases it is a *general law,* or more accurately, an amendment to the general laws. The law that was amended in this case was Chapter 23B of the Massachusetts General Laws. General laws are called *statutes*. An *enabling statute* is a mechanism by which the legislature *delegates* its authority to develop laws to an agency of the executive branch. This enables the agency to promulgate *regulations*.

When the State Building Code Commission was reconstituted in 1984, its name was changed to the State Board of Building Regulations and Standards. The legislation effecting this change was entitled chapter 348 of the acts of 1984. This law amended chapter 143 of the Massachusetts General Laws. MGL chapter 143 is the basic enabling statute for public safety just as MGL chapter 111 is the basic enabling statute for public health.

These two *enabling statutes* have something in common: Both involve the employment of what are called, the *police powers* of the state. Our founding fathers were understandably distrustful of governmental power. They nevertheless recognized that the imposition of state authority would be necessary to "protect the health, safety, morals, order, peace, comfort, and general welfare of the people." Police powers were regarded to be "plenary and inherent" in the sovereign government because the protection of the "public health and safety" was (and still is) considered one of the primary purposes of government.

The possession of the police powers of the state gives considerable authority to these regulations: violations of building code provisions are handled as matters *at law* (the criminal side of the court) rather than matters *at equity* (the civil side). Consequently, building codes are central in the enforcement process of several other forms of regulation. Zoning ordinances, flood plain regulations, wetlands protection laws, historical preservation regulations, rent control provisions, and many other regulatory efforts derive their enforcement power from linkage with the building code. These *secondary codes* are not always properly deserving of the police powers. For example, *zoning* has been held by the courts to extend legitimately from the police powers owing to its similarity in function to *nuisance* laws. This rationale has been accepted only after a number of tightly contested and narrowly stated judicial decisions, and there is evidence that contemporary courts have begun to turn the tide on what many have argued has become a systematic erosion of *rights in property*. A variety of other secondary codes have been challenged using arguments that compare the enforcement of these measures to *condemnation* (taking for public use) or to the inappropriate use of the police powers. Linkages with the building code are made either by proscribing the issue of a building permit in the event of noncompliance with the secondary code or by vesting in the office of the building commissioner affirmative enforcement responsibilities. One example of the operative language linking these codes can be found in section 114.1 of the building code, which governs the issuance of permits:

> § 114.1 Action on application: The building commissioner or inspector of buildings shall examine or cause to be examined all applications for permits and amendments thereto within thirty (30) days after filing. If the application or the plans do not conform to the requirements of Section 113.0 or other related sections of this code *or of all pertinent laws,* he shall reject such application in writing citing the specific sections of this code *or pertinent law.* If he is satisfied that the proposed work conforms to the requirements of this code *and all pertinent law applicable thereto,* he shall issue a permit. (Emphasis added.)

AUTHORSHIP

Senator Robert Taft, quoted at the beginning of this chapter, was notorious for his uncompromising cynicism regarding government by committee. It is said that he was shaving on the morning when the news reached the United States that Charles Lindbergh had successfully completed a solo airplane flight across the Atlantic Ocean. He paused for a moment contemplating his razor. Finally he said, "I knew he would do it. It would have been a miracle if a *committee* had done it."

We don't expect that the men and women we periodically elect to office

in our state government can be intimately familiar with all aspects of building construction. Indeed, familiarity with all aspects of the technologies the building code addresses itself would require something in excess of moderate genius. Consequently, when the leaders of a political jurisdiction contemplate the adoption or revision of a code, they employ specialized talent.

The State Board of Building Regulations and Standards is composed of eleven members, nine appointed by the governor and two who serve ex officio (by virtue of office). The two ex officio members are the state fire marshall and the chief of inspections in the department of public safety. The nine appointed members are required by statute to represent a particular discipline or organization with an interest in the regulation of construction methods and materials. These representatives include:

a registered architect

a registered mechanical engineer

a registered structural engineer

a representative of the building trades

a general contractor who builds commercial or industrial buildings

a general contractor who builds one- and two-family homes

a local fire chief

an inspector of buildings who serves a town in Massachusetts

an inspector of buildings who serves a city in Massachusetts

This is broad representation of skilled professionals, but it is not exhaustive of all groups of people who might possibly have an interest in the formulation of a building code. The board members also have full-time commitments to their professions. To ask such a group of people to sit down and write a 1,000-page document that will have to be both legally and technically precise would be imposing quite heavily on the time and talent they have so generously agreed to donate to the service of state government. Moreover, recognizing that there is no need to "reinvent the wheel," a cursory look at model codes and possibly a detailed look at the enforcement systems used in other states could save a good deal of unnecessary time and effort.

There are, in the United States, three major code writing organizations:

Building Officials and Code Administrators International (BOCA), 4051 West Flossmore Road, Country Club Hills, Illinois 60477. Their code, the *Basic/National Building Code,* has been adopted in various editions and with local modifications throughout the north central United States, extending into the northeastern states and into some of the Middle Atlantic states.

Southern Building Code Congress International (SBCC), 900 Montclair Road, Birmingham, Alabama 35213. Their code, the *Standard Building Code,* has been adopted throughout the southeastern and south central states and some of the Middle Atlantic states.

International Conference of Building Officials (ICBO), 5360 South Workman Mill Road, Whittier, California 90601. Their code, the *Uniform Building Code,* is adopted throughout the western states and the noncontiguous states of Hawaii and Alaska.

It seems that the three major code writing organizations have "agreed to disagree" on a few nonessential issues. There are only slight variations between them in substantive provisions. Moreover, each subsequent edition seems to demonstrate a striking convergence of opinion regarding the proper areas and methods of regulation.

There is a joint organization that invites representatives of these code writing groups to meet and discuss ideas concerning revisions, new methods or materials of construction, legal matters, and practical problems that present themselves to the code enforcement community:

Council of American Building Officials (CABO), 5203 Leesburg Pike, Suite 708, Falls Church, Virginia 22041.

Through the Council of American Building Officials, the three major code writing organizations have coordinated their efforts to produce a code for the construction of "one- and two-family dwellings." This code, called the "CABO One- and Two-Family Dwelling Code," has been widely adopted throughout the United States (again with local modifications).

Another organization of note, the National Fire Protection Association (NFPA), headquartered here in Batterymarch Park, Quincy, Massachusetts, is a writer of codes that have been adopted internationally. All of the codes mentioned above contain references to the National Fire Codes, a multivolume work that contains, among others, the National Electrical Code (NFPA 70), the Life Safety Code (NFPA 101), and the standards for The Installation of Sprinkler Systems (NFPA 13). The Massachusetts State Building Code references this organization with the letters NFiPA to distinguish it from the

National Forest Products Association (NFoPA), an organization that also calls itself the NFPA.

The Massachusetts State Building Code Commission adopted the 1978 BOCA code as the basic fabric of the fourth edition of the Massachusetts State Building Code. This edition was promulgated by the Massachusetts General Court in 1980. As of this writing, the fourth edition, whose most recent amendments are dated May 1, 1990, is the law of the Commonwealth. Work is in progress to adopt the 1987 BOCA code as the basic fabric of the fifth edition of the Massachusetts State Building Code. Modifications to this document are under discussion as of this writing. Per the enabling statute, any discussion of modifications is required to be open to the public and to consider suggestions from all concerned parties.

BACKGROUND READING

Botsford, M., and Matz, R.G.(eds.) *Handbook of Legal Research in Massachusetts*, Boston: Massachusetts Continuing Legal Education Inc., 1982. This is one of a variety of extremely helpful publications produced by MCLE.

Coates, Gary. *Resettling America: Energy, Ecology and Community*. Andover, Mass.: Brick House Publishing Co., 1981. This is a hopeful book that looks at the postindustrial community and the "soft path" technology available to contemporary builders of communities. We must be ever vigilant so that building codes remain flexible enough to accommodate innovation.

Constitution of the Commonwealth of Massachusetts. Office of the Massachusetts Secretary of State, 1984. The last time I checked, copies of the Massachusetts Constitution could be obtained free of charge at the State House Bookstore.

Menard, C. S., *Research Guide to the Massachusetts Courts and their Records*. Massachusetts Supreme Judicial Court, 1987. This is a fine introduction to the operation of the Massachusetts court system, its structure, and recordkeeping procedures.

Myers, J.J., and Noble, C.L. *Massachusetts Construction Law*. Eau Claire, Wis.: Professional Education Systems Inc., 1987. This provides a useful overview of public and private construction contracts and dispute settlement procedures.

Turner, J.F.C., and Fichter, R. *Freedom to Build*. New York: Macmillan, 1972. This is a well-reasoned indictment of building codes based on research done at the Harvard/MIT Joint Center for Urban Studies.

2
Decoding the Code

"Define a thing and you can dispense with it."
—Richard Farina

DEFINITIONS

The interpretation of any document requires a familiarity with the uses of the words that compose it. It behooves us, at the outset, to identify a few words or combinations of words that may or may not be used in popular speech but have quite specific meanings when used in the building code. Many words used in the code have formal definitions. Many readers of the code handicap themselves in their reading by ignoring the importance of formal definitions.

To define means necessarily to delimit. A good definition is constructed so that the reader can readily distinguish what is included under the definition from what is not. Legal definitions are particularly important. When a term is defined explicitly in a legal text, it may vary from ordinary meaning. When the text is interpreted, the ordinary meaning yields to the explicit definition. The following memorandum prepared by the late W. Barton Leach[1] illustrates this principle.

> MEMORANDUM
> TO: Harvard Law Faculty and Teaching Fellows
>
> I have recently come across a Canadian case which merits the attention of each of you. It is not officially reported but appears in 8 Criminal Law Quarterly 137 (Toronto, 1965) (permission to reproduce granted by Criminal Law Quarterly) and is reprinted in a volume entitled Legislation and the Courts at page 512. The case is *Regina v. Ojibway*. If it had a headnote, which it does not, it would be something like this:
>
> Is a pony, fortuitously saddled with a feather pillow, a "small bird" within the meaning of the Ontario Small Birds Act?
>
> I here reproduce the opinion in full as above reported:

[1] The memo and case can be found in Casner, A. James, and Leach, W. Barton. *Cases and Text on Property*. Toronto: Little, Brown, and Co., 1984.

(IN THE SUPREME COURT)
REGINA v. OJIBWAY

Blue,J. August
1965

Blue,J.—This is an appeal by the crown by way of a stated case from a decision of the magistrate acquitting the accused of a charge under the Small Birds Act, R(oyal).S(tatutes of).O(ntario)., 1960, c. 724, s. 2. The facts are not in dispute. Fred Ojibway, an Indian, was riding his pony through Queens Park on January 2, 1965. Being impoverished, and having been forced to pledge his saddle, he substituted a downy pillow in lieu of said saddle. On this particular day, the accused's misfortune was further heightened by the circumstances of his pony breaking its right foreleg. In accord with Indian custom, the accused then shot the pony to relieve it of its awkwardness.

The accused was then charged with having breached the Small Birds Act, s.2 of which states: "2. Anyone maiming, injuring or killing small birds is guilty of an offence and subject to a fine not in excess of two hundred dollars." The learned magistrate acquitted the accused holding, in fact, that he had killed his horse and not a small bird. With respect, I cannot agree.

In light of the definition section, my course is quite clear. Section 1 defines "bird" as "a two legged animal covered with feathers." There can be no doubt that this case is covered by this section.

So far we know that the case is an appeal that is argued by the prosecutor. To appeal a case to a higher court requires that the dispute concerns a matter of *law* not a matter of *fact*. In this case there is agreement between both parties as to the facts of the case. The disputed issue concerns the definition of the words "small bird." The prosecutor argues that Ojibway's pony is a small bird within the meaning of the law:

Counsel for the accused made several ingenious arguments to which, in fairness, I must address myself. He submitted that the evidence of the expert clearly concluded that the animal in question was a pony and not a bird, but this is not the issue. We are not interested in whether the animal in question is a bird or not in fact, but whether it is one in law. Statutory interpretation has forced many a horse to eat birdseed for the rest of its life.

Some examples that arise in the interpretation of the building code come to mind. One example involves the definition of "frost line."

<u>EXAMPLE 1</u> Anyone who routinely witnesses excavations during the winter can see that the ground is usually frozen to a depth of approximately 12 inches. During extremely cold weather (particularly if there is no snow cover), the frost may penetrate as deep as 3 feet. But to assure something of a margin for error in the placement of footings, Section 724.1 of the building

code requires that permanent supports for buildings or structures be placed at a depth of 4 feet. Four feet becomes the depth of the imaginary frost line, that is, the frost line in law, regardless of what it may be in fact.

<u>EXAMPLE 2</u> Another example involves the words "ordinary repairs," a phrase that is not likely to inspire a trip to the dictionary. But the phrase is commonly used in a way that differs from the way in which the building code defines it. We find this definition in article 2 of the code (§ 201.0, page 71) alphabetically listed under the letter *R*. "Repairs, ordinary" is defined as "any maintenance which does not affect structure, egress, fire protection systems, fire ratings, energy conservation provisions, plumbing, sanitary, gas, electrical or other utilities. A building permit is not required for ordinary repairs."

This definition is important for two reasons. First, as mentioned above, it is a counterintuitive definition, meaning more than its ordinary use would suggest. Second, it is an example of a requirement imbedded in a definition. Because a building permit is not required for ordinary repairs, it is necessary to give specific criteria for the use of these words.

<u>EXAMPLE 3</u> A third example is a "flight of stairs." We walk up and down flights of stairs every day and we don't feel that we need to be told what they are. But a "flight of stairs" has a quite specific meaning in the building code, and it is defined as follows in article 2 of the code (on page 77): "One or more flights of stairs, and the necessary landings and platforms connecting to them, to form a continuous and uninterrupted passage from one floor to another. A flight of stairs, for the purposes of this code, must have at least three risers." Two steps then, (that is, two risers) would not be a flight of stairs and would therefore be exempt from several provisions that pertain to a flight of stairs.

With these examples we can appreciate the foundation that our prosecutor has laid for his argument. His next step is to dismantle his opponent's contentions by highlighting their lack of relevance to the question at issue.

> Counsel also contended that the neighing noise emitted by the animal could not possibly be produced by a bird. With respect, the sounds emitted by an animal are irrelevant to its nature, for a bird is no less a bird because it is silent.
>
> Counsel for the accused also argued that since there was evidence to show that the accused had ridden the animal, this pointed to the fact that it could not be a bird, but was actually a pony. Obviously, this avoids the issue. The issue is not whether the animal was ridden or not, but whether it was shot or not, for to ride a pony or a bird is of no offence at all. I believe counsel now sees his mistake.
>
> Counsel contends that the iron shoes found on the animal decisively

> disqualify it from being a bird. I must inform counsel, however, that how an animal dresses is of no concern to this court.
>
> Counsel relied on the decision in Re Chickadee, where he contends that in similar circumstances the accused was acquitted. However, this is a horse of a different color. A close reading of that case indicates that the animal in question there was not a small bird, but a midget of a much larger species. Therefore, that case is inapplicable to our facts.
>
> Counsel finally submits that the word "Small" in the title Small Birds Act refers not to "Birds" but to "Act," making it the Small Act relating to Birds. With respect, counsel did not do his homework very well, for the Large Birds Act R.S.O. 1960, c.725, is just as small. If pressed, I need only to refer to the Small Loans Act, R.S.O. 1960, c.727 which is twice as large as the Large Birds Act.

And now our prosecutor is ready to construct his own argument. He emphasizes the definition and proceeds to articulate the reasons why a pony should be included under the definition of a small bird:

> It remains then to state my reason for judgement which, simply, is as follows: Different things may take on the same meaning for different purposes. For the purpose of the Small Birds Act, all two-legged, feather-covered animals are birds. This, of course, does not imply that only two-legged animals qualify, for the legislative intent is to make two legs merely the minimum requirement. The statute therefore contemplated multi-legged animals with feathers as well. Counsel submits that having regard to the purpose of the statute only small animals "naturally covered" with feathers could have been contemplated. However, had this been the intention of the legislature, I am certain that the phrase "naturally covered" would have been expressly inserted just as "long" was inserted in the Longshoreman's Act.

Our prosecutor has by now dazzled his audience with argument. He now phrases his argument in a cogent statement made ever the more powerful by the "hardness of the logical *must*":

> Therefore, a horse with feathers on its back must be deemed for the purposes of this act to be a bird, and a fortiori, a pony with feathers on its back is a small bird.

Sensing that he has scored a direct hit, our prosecutor takes a moment to dismantle one more of the defendants arguments:

> Counsel posed the following rhetorical question: If the pillow had been removed prior to the shooting, would the animal still be a bird? To this let me answer rhetorically: Is a bird any less of a bird without its feathers?
>
> APPEAL ALLOWED

Why did this memo circulate the hallowed halls of Harvard Law School? Why would such luminaries as Professors Casner and Leach be inclined to direct the attention of the Harvard law faculty to such a silly set of arguments?

First, this case provides an illuminating insight into the difference between the principles of legal reasoning and the principles that we are following when we are using "common sense." We generally feel that if the acceptance of a premise leads to an absurd conclusion, the premise is impeached. But using legal reasoning this is not necessarily so.

Second, the case is a fine illustration of the importance of definitions. If in the drafting of a legal document it is determined to be necessary to define a term explicitly, the explicit definition will then be presumed to be superior to "ordinary meaning" for the purpose of interpreting the document. It is therefore essential to study the definition section of any regulatory document. The building code is no exception. Whenever the experienced code reader is puzzled by the language of the code, the memory of the Small Birds Act should inspire further study of Section 201.0.

Finally, not all definitions are listed in the definition section of the code. Just as in the example of "ordinary repairs" we find a *requirement* disguised as a *definition*, there are definitions that are found in the text of the code. These are *definitions* masquerading as *requirements*. One example of this is Section 857.5.6.1 in the materials section of the code. Safety glazing conforming to the provisions of ANSI Z97.1 (a reference standard listed in appendix B of the code) is required to be provided in specific hazardous locations known as *human impact areas*, which Section 857.5.6.1 defines as follows:

> § 857.5.6.1 Specific hazardous locations: The following shall be considered specific hazardous locations for purposes of glazing:
>
> 1. glazing in ingress and egress doors except wired glass in required fire doors and jalousies (see § 857.5.5);
> 2. glazing in fixed and sliding panels of sliding type doors (patio and mall type);
> 3. glazing in storm doors;
> 4. glazing in all unframed swinging doors;
> 5. glazing in ingress and egress doors except wired glass in required fire doors and jalousies (see § 857.5.5);
> 6. glazing, operable or nonoperable, whose nearest vertical edge is within forty-eight (48) inches of a door in nonresidential occupancies or within twelve (12) inches of a door in residential occupancies and

whose bottom edge is below the top of the door unless an intervening interior permanent wall is between the door and the glazing; and

7. glazing in fixed panels having a glazed area in excess of nine (9) square feet with the lowest edge less than eighteen (18) inches above the finish floor level or walking surface and having a walking surface on both sides, both of which are within thirty six (36) inches of such glazing and the horizontal planes of such surfaces are within twelve (12) inches of each other. In lieu of safety glazing, such panels may be protected with a horizontal member not less than one and one-half (1½) inches in width when located between twenty-four (24) and thirty-six (36) inches above the walking surface.

There are a variety of impediments to understanding this passage beyond the fact that it is a misplaced definition. If it were intended to confuse the reader, it could not have been more expertly composed, as any attempt to diagram the sentences will reveal. Particularly amusing is the refrain in parts 1 and 5. Some view this as a simple typographical error, and others have hypothesized that the repetition is for emphasis. Still others have suggested that it is a poetic refrain and that if the definition in this passage were to contain one more part, the refrain would be repeated once again.

The following discussion focuses on a few particular terms that are useful to readers of building codes. In the first section, which we call the "*lexicon regulata*," we examine the forms of statements and use of some terms that are peculiar to the legal language of the code. In the second, which we call the "*lexicon technologia*," we examine words that have a specific technical meaning within the construction trades or design professions.

LEXICON REGULATA

It is useful to think of building code statements as being of two forms: *mandatory* and *permissive*. It is further useful to regard statements as being expressed in four types: *prescriptions*, *proscriptions*, *contingencies*, and *disclaimers*. There are few sections of the building code that can be exclusively classified in one of these categories. It is more common for a paragraph to contain a mixture. Nevertheless, in the attempt to unravel the meaning of the complex grammatical structure or the compound requirements contained in the language of the code, these categories can be used to break a requirement down into reasonably simple components. This system of simplification comes with no guarantees. The persistant use of "legalese," "technicalese," and Victorian English by code writers provides a formidable challenge to any system of simplification.

Mandatory Statements

Mandatory statements are characterized by the use of the words "must" or "shall." Statements of this type signify an affirmative obligation to act.

EXAMPLE § 107.1 Appointment: The chief administrative officer of each city or town shall employ and designate an inspector of buildings or building commissioner, as well as such other local inspectors as are reasonably necessary. The inspector of buildings or building commissioner shall report directly and be solely responsible to the appointing authority.

This passage simply mandates a city or town in Massachusetts to appoint a building inspector together with whatever staff is necessary to get the job done. The inspector of buildings office is required to be organized directly under the appointing authority.

Permissive Statements

Permissive statements are usually identified by the use of the word "may," which indicates a choice or discretion on the part of whoever is governed by the passage.

EXAMPLE 1 § 126.1 State Building Code Appeals Board: Whoever is aggrieved by an interpretation, order, requirement, direction or failure to act under this code by any agency or official of a city, town or region or agency or official of the state charged with the administration or enforcement of this code or any of its rules or regulations, except any specialized codes, may appeal directly to the State Building Code Appeals Board as provided in § 126.0.

In this passage, the right of anyone to avail himself or herself of the due process is affirmed. To qualify, one need only be "aggrieved."

There are a number of passages in the building code that contain a mix of mandatory and permissive conditions.

EXAMPLE 2 § 111.2 Inspection: The building official shall make all required inspections as specified in the provisions of this code and he shall conduct such inspections from time to time during and upon completion of the work for which he has issued a permit; and he shall maintain a record of all such examinations and inspections and of all violations of this code. In conjunction with specific construction projects, the building official may designate specific points in the course of construction that require the contractor or builder to give the building official twenty-four (24) hours

notice prior to the time when those inspections need to be performed. The building official shall make the inspections within forty-eight (48) hours after such notification.

Prescriptions

Prescriptions are of the form "thou shalt" and are usually called requirements. Prescriptions are usually the most direct statements in the code and most readers find them easiest to understand.

EXAMPLE 1 § 610.2 Dead ends: Exitway access passageways and corridors in all stories which serve more than one (1) exitway shall provide direct connections to such exitways in opposite directions from any point in the passageway or corridor, insofar as practicable. The length of dead end corridor shall not be more than twenty (20) feet.

Here is a requirement for a corridor to provide its occupant with a choice of two directions in which to travel, each leading to an exit. A corridor with only one choice is a "dead end" corridor and is limited to 20 feet in length. The following example prescribes the sizes of doors in a building:

EXAMPLE 2 § 612.3 Size of doors: The minimum width of single door openings shall provide a clear width of not less than thirty-two (32) inches except in one- and two-family dwellings (use groups R-3 and R-4) the clear width shall be not less than twenty-eight (28) inches. The maximum width shall be forty-eight (48) inches nominal. Means of egress doors in institutional buildings (use group I) used for the movement of beds shall be at least forty-four (44) inches wide. When the doorway is subdivided into two (2) or more separate openings, the minimum clear width of one (1) opening shall be not less than thirty-two (32) inches, and each opening shall be computed separately in determining the required number of units of egress width. The height of doors shall not be less than six and two-thirds (6⅔) feet except in one- and two-family dwellings (use groups R-3 and R-4) the height of doors shall be not less than six and one-half (6½) feet.

Proscriptions

Proscriptions are of the form "thou shalt not" and are usually called "prohibitions." These are often unequivocal statements that are distinguished from prescriptions by the use of negative terms such as "no" or "not."

EXAMPLE 1 § 107.5 Restriction on employees: No full-time building commissioner, inspector of buildings, or full-time local inspector as defined

herein shall be engaged in or directly or indirectly connected with the furnishing of labor, materials or appliances for the construction, alteration or maintenance of a building or structure, of the preparation of plans or of specification therefor within the city, town, or region, for which he is appointed, unless he is the owner of the building or structure; nor shall any officer or employee associated with the building department engage in any work which conflicts with his official duties or with the interests of the department.

Some prohibitions are stated in a form that does not contain the words "no" or "not." Instead they contain a positive statement that describes an act or omission or condition as a violation of the law. For example, Section 600.3, which prohibits the diminishing of the required exit capacity, states the following:

EXAMPLE 2 § 600.3 Minimum requirements: It shall be unlawful to alter any building or structure in any manner that will reduce the number of exitways or the capacity of exitways below the requirements of this code for new buildings of the proposed use and occupancy.

Contingencies

Contingencies are requirements or prohibitions that apply when certain conditions are met. Phrases such as "unless otherwise specified" or "whenever" or "except for" or "if . . . then" are the hallmarks of a contingency. In examining code language of this type, it is necessary to examine the *conditional* portion of the statement in order to determine if the *operational* part of the statement applies.

EXAMPLE 1 § 101.2 Zoning restrictions: When the provisions herein specified for structural strength, adequate egress facilities, sanitary conditions, equipment, light and ventilation, and fire safety conflict with the local zoning by-laws or ordinances, this code shall control the erection or alteration of buildings.

Here the condition involves a situation in which the provision of the local zoning ordinance presents an impediment to an otherwise sound design decision. If the interest of fire safety is served, for example, by providing an exterior exit stairway and the location of the stairway would violate the zoning setback requirements, the interest of safety is presumed superior to the local zoning bylaws, and the building code provisions would prevail.

EXAMPLE 2 § 109.1.1 Licensing of Construction Supervisors: Except for those structures governed by construction control in § 127.0, effective

September 1, 1982 no individual shall be engaged in directly supervising persons engaged in construction, reconstruction, alteration, repair, removal or demolition involving the structural elements of buildings and structures, unless he or she is licensed in accordance with the Rules and Regulations for Licensing Construction Supervisors.

Exception: Any Home Owner performing work for which a building permit is required shall be exempt from the provisions of this section; provided that if a Home Owner engages a person(s) for hire to do such work, that such Home Owner shall act as supervisor.

For purposes of this section only, a Home Owner is defined as follows:

Person(s) who owns a parcel of land on which he/she resides or intends to reside, on which there is, or is intended to be, a dwelling of six or less units, attached or detached structures accessory to such use and/or farm structures. A person who constructs more than one home in a two-year period shall not be considered a homeowner.

The first contingency in this regulation is a reference to controlled construction. *Construction Control* (§ 127.0) refers to large construction projects (generally those in excess of 35,000 cubic feet) that require the services of design professionals. In such projects, the design must be accompanied with the seals of registered architects and engineers certifying compliance with the code. Additionally, a detailed reporting system is arranged in which registered architects or engineers conduct inspections, certify compliance with the code, and report to the building official who retains final authority for approval.

The second contingency is an exception for a home owner who is allowed to supervise structural work performed on his own property. Code writers anticipated that this exception would become a loophole of sorts, allowing unlicensed supervision of construction through the use of fluid or protean ownership arrangements. They therefore made certain to define "home owner" within the passage. This is an example of a definition hidden in a regulation. There is no definition of "home owner" in the definition section of the code (§ 201.0)

There are a number of contingencies in the code that are cued by the words "acceptable to the *authority having jurisdiction*." This phrase is more likely to appear in the model codes or the secondary codes but not exclusively. Since the model code writers are not likely to be familiar with the specific details of legal authority in any particular jurisdiction, this phrase is a general expression that is intended to refer to the actual regulatory apparatus in the jurisdiction in which the code is adopted. Identifying the proper authority may at times be difficult. The phrase most often refers to the local building official, but under a state building code the local official is not the tower of authority that most who enter his office

believe. In the days before Massachusetts adopted a state building code, each city or town had original authority to promulgate and enforce a building code. These codes might have been written independently (as was the case in Boston, Worcester, and Springfield) or the city or town might have adopted some edition of a model code. In this case, the authority having jurisdiction would be the local inspector or commissioner of buildings.

Today in Massachusetts the regulatory authority is considerably more diffuse. The State Board of Building Regulations and Standards has authority to promulgate a state building code and interpret its provisions. The State Building Code Board of Appeals (§ 126.0) has authority to vary the application of provisions of the code when in the opinion of the board the strict application of the code would constitute a "manifest injustice" (§ 126.4.2) and the proposed alternatives to compliance would provide the same degree of protection to the public safety as would strict compliance. There are local boards of appeal (§ 126.7) that may act in a similar capacity but any decision handed down by a local board is required to be reviewed by the State Building Code Appeals Board (§ 126.7.12), which may accept the decision of the local board or require an "appeal de novo," which means "new appeal," starting from the beginning—as though the appeal before the local board had never been held.

The local inspector of buildings has authority and responsibility to enforce the provisions of the building code, to issue or revoke permits (§ 114.0), to issue orders or notices to abate unsafe or illegal conditions (§ 123.0 and § 124.0), to conduct periodic inspections of existing buildings (§ 108.0), and to enforce precautions during construction operations (article 13) issuing any notices or orders appropriate to protect the workmen or the public. The state inspector has authority and responsibility to make periodic reviews of the operations of the local building departments and provides technical assistance and advice to the local inspector. The commissioner of the Massachusetts Department of Public Safety has authority to review, upon his own initiative or upon a request of the state inspector, the performance of the local inspector regarding the enforcement of the building code and may reverse, modify, or annul in whole or in part any action of the local inspector, provided that this action does not contravene any decision of the State Building Code Board of Appeals.

In Massachusetts, the phrase "authority having jurisdiction" refers to a complex of hierarchical and counterbalanced powers. It should be regarded as a contingency that defers to one or more members of this hierarchy depending upon the particular issue involved.

Disclaimers

Disclaimers repudiate or renounce a power, right, or interest vested in the code. They oftentimes refer the reader to language or principles that lie outside of the regulation or passage in which the disclaimer is found.

EXAMPLE 1 § 140.1 General: The provisions of this code are severable, and if any of its provisions are held to be unconstitutional or otherwise invalid by any court of competent jurisdiction, the decision of such court shall not affect or impair any of the remaining provisions.

In this passage the code writers inform the reader that they are not fully confident of the constitutionality of all of the provisions of the code. The severability clause is intended to maintain the integrity of the code in the event that some provisions are "struck down" by the courts.

EXAMPLE 2 § 2101.1.2 Alternate materials, methods of construction, design or insulating systems: The provisions of this article are not intended to prevent the use of any material, method of construction, design or insulating system not specifically prescribed herein, provided that such construction, design or insulating system has been approved as specified in § 110.0

Section 110.0 gives four criteria for allowing the use of uncommon designs, methods, or materials. The first involves conformance to *accepted engineering practice* as defined in the appropriate appendices. Since a designer is allowed to be original, it follows that there will be designs that have not been anticipated by the code writers. So long as design professionals proceed within the norms of their profession as defined by their respective boards of registration, original designs will be acceptable.

The second criterion for the use of uncommon designs addresses the case of used materials. There is a long and noble tradition of appropriating materials from obsolete structures. Not even Michelangelo insisted on stone fresh from the quarry. When building materials are reused, the approval of the building official is required. Evidence of the strength, durability, and general soundness of the material must be supplied.

The third criterion involves the use of a method or material with which the building official is unfamiliar or uncertain, in which case the building official is empowered to require whatever tests or certifications are deemed necessary. The data the building official receives must be forwarded to the State Board of Building Regulations and Standards within ten days of receipt.

In the fourth case, which involves new or innovative methods or materials of construction, affirmative approval must be received from the Construction Materials Safety Board as provided for in Section 128.0

LEXICON TECHNOLOGIA

We would presume that anyone who has reason to read a building code has little difficulty with the concept *building*. Yet there are some subtleties in

the definition that are not transparent to the casual reader. First of all, a building is a *structure*, but a structure is not necessarily a building. A structure is defined in Section 201.0 of the code (on page 77) with the following words:

> A combination of materials assembled at a fixed location to give support or shelter, such as a building, framework, retaining wall, tent, reviewing stand, platform, bin, fence, sign, flagpole, recreational tramway, mast for radio antenna or the like. The word structure shall be construed, where the context requires, as though followed by the words "or part or parts thereof."

Building is defined (on page 45) as follows:

> A structure enclosed within exterior walls or fire walls, built, erected and framed of a combination of any materials, whether portable or fixed, having a roof to form a structure for the shelter of persons, animals, or property. For the purpose of this definition, "roof" shall include an awning or any similar covering, whether or not permanent in nature. The word "building" shall be construed where the context requires as though followed by the words "or part or parts thereof."

The two important subtleties in the definition of "building" are these: first, a building (unlike a structure) has a *roof* and is presumed to be *occupied* by persons, animals, or property, and second, a building is located within *exterior walls* or *fire walls*. Consequently, the concept of a fire wall must be understood in order to comprehend the definition of a building.

A *fire wall* is defined (on page 56) as follows:

> A fireresistance rated wall, having protected openings, which restricts the spread of fire and extends continuously from the foundation to or through the roof. (There is a more detailed description in § 907.0 of the code (on page 380.)

A fire-resistive wall can take one of two forms: a fire separation wall or a fire wall. Both types have a *fire resistance rating*, a rating conferred upon building assemblies (walls, floors, roof/ceiling assemblies, and so forth) by testing laboratories that subject a specimen, for example, a wall, to a test in a fire chamber. Details of the procedure for testing fire resistance are provided in the *Standard Method of Fire Tests for Building Construction and Materials*. The various standards agencies have their own numerical designations for this test. The American Society for Testing and Materials calls it the ASTM E-119; the National Fire Protection Association calls it the NFPA 251; and the American National Standards Institute calls it the ANSI 2.1.

In the test chamber the mean temperature is required to conform to a

time-temperature curve. (The values on this curve are given in appendix H, page 726 of the code.) The test is concluded when flame passes through the assembly or when the assembly fails, or when the thermocouples attached to the test assembly register target values, which differ depending on which kind of assembly is being tested (wall, column, beam, floor-ceiling, roof-ceiling, and so forth). The time elapsed between the beginning of the test and the end of the test yields a *fire resistance rating*, which is expressed in hours. Details of the construction of the assembly are published by the testing agencies together with an identification number. Underwriters Laboratories, Factory Mutual Research and Engineering, the National Board of Fire Underwriters, the American Gypsum Association, and a variety of other organizations publish directories that include this information.

A *fire wall* must satisfy a number of criteria. It must be noncombustible. There are combustible (wood frame) fire separation walls, but there are no combustible fire walls. A fire wall must also be structurally independent, that is, it must be capable of withstanding the structural collapse of the building on either side of the wall without causing collapse on the opposite side of the wall. Consequently, a fire wall must be independently footed.

The code allows a building that is partitioned by a fire wall to be treated as two buildings. Each building can then be analyzed separately for the purpose of applying the code.

Fire walls and fire separation walls are among a variety of building components that have fire-resistive ratings. As mentioned above, building elements such as columns, beams, floor/ceiling assemblies, roof/ceiling assemblies, and doors may also be required to have ratings. The word "protected" is used to refer to a rated assembly. For example, building inspectors frequently refer to a 1-hour protected column, or a 2-hour protected shaft wall, or a 1½-hour protected door. It is not uncommon for designers to refer to a building that has been equipped with a sprinkler system as a "protected" building. This is probably because the code often uses the phrase "unless protected throughout by an automatic suppression system." To avoid confusion, the code community has evolved a convention for using the terms *protected, suppressed,* and *full suppression*. *Protected* refers to a *construction type* in which various structural elements of the building are *rated* (have been constructed in a manner that affords a fire-resistive rating). Buildings or areas of buildings that have been equipped with sprinkler systems or dry chemical systems or halogen systems, and so forth, are said to be *suppressed*. *Full suppression* refers to a water-based sprinkler system that has been installed in accordance with NFPA 13 and covers, basically, every nook and cranny in the building.

3

Articles and Appendices: A Brief Glance

"Though the materials of experience are established, we are poetic in our rearrangement of them."

—Kenneth Burke

Page 82 in appendix 5 of this manual contains what is called a *tabbing index*. It is basically the table of contents from the building code with some tables and illustrations added. It is suggested that the reader purchase a set of tabs and attach the labels to the code sections indicated. This, more than any single measure, will simplify the task of breaking down the code into digestible pieces. Once this is done, read carefully the following section in its entirety. It contains a brief description of the content of each article of the code. The reader may wish to refer to this section frequently for orientation and is urged to do so.

THE ARTICLES

Article 1: Procedure

Article 1, "Administration and Enforcement," contains the rules of the game. If you want to know when you need a permit, if you need a construction supervisors license, what procedures are involved in obtaining a permit or certificate of occupancy, or when a registered architect or engineer is required for design, this is the article to consult.

Some of this article is written for the inspector of buildings. It gives assignments, schedules periodic inspections of specific occupancies, outlines the powers and duties of building officials, specifies procedures for

enforcement activity, and outlines criteria for the issuance of stop-work orders and the revocation of permits.

Also included in this article are procedures of operation for the State Building Code Board of Appeals that both enable and circumscribe the activities of local boards of appeal.

Section 127 outlines the procedures for *construction control,* which pertains to the construction of buildings exceeding 35,000 cubic feet in size. This section delegates many of the site responsibilities for inspection, recordkeeping, and reporting to registered professional architects and engineers.

Article 2: Definitions

This article contains three parts. The first part is a dictionary-style section that defines terms used in the code. It is well to remember that these are *legal* definitions.

The second part defines the classification of *construction types*. Each building is classified as conforming to one of the listed construction types, based on the *material of construction* and the *fire resistance ratings* of structural components of the building. Table 214 of the code defines, in matrix form, the construction types, listing the required fire resistance ratings.

The third part of article 2 defines the classification of *occupancy types*. Any activity conducted within a building will fall into one of these classifications.

Many code requirements are contingent upon the construction type and the occupancy of the building. It is necessary to establish these classifications before any code requirements can be determined. A detailed discussion of this contingency is provided in chapter 4 of this book.

Article 3: General Building Limitations

A building is limited in *height* and *area* as a function of its *construction type* and *occupancy*.

Table 305 of the code details height and area limitations, and these "tabular areas" are modified by the subsequent sections. Additional issues such as permissible projections, street encroachments, requirements within "fire limits," and accessibility for the physically handicapped are contained in this article. A detailed discussion of this procedure is contained in chapter 4 of this book.

Article 4: Special Use and Occupancy

Certain uses, activities, or types of buildings, such as windowless or high-rise buildings, are perceived to represent an increased risk to the safety of the occupants. Many of these have a demonstrated record of fatality in fire incidents. Therefore they are treated as special design problems with special design requirements.

Readers are urged to study this article so that when they encounter a *special occupancy,* they will recognize it immediately. It is usual for a design professional who has developed a specialized practice to be involved in the design of health care facilities, covered malls, theaters, and facilities in which highly volatile or explosive substances are kept or used.

There are details in article 4 governing places of public assembly, amusement parks, stadia and grandstands, drive-in motion picture theaters, parking lots, public and private garages, radio and television towers and antennae, swimming pools, high-rise buildings, open wells and atria, and fallout shelters.

❖

REVIEW

Notice that in the first four articles there are few "code requirements."

Article 1: Procedures have been described.

Article 2: Terms have been defined.

Article 3: General limitations on height and area have been set.

Article 4: Special design problems have been identified.

With readers properly oriented by these articles, they are now prepared to discuss those articles that contain substantive provisions.

Article 5: Light, Ventilation, and Sound Transmission Control

It was in the nineteenth century that the requirements for the provision for light and ventilation first emerged in this country. This was done in response to a series of epidemics that occurred throughout the nation as well as in response to a general popular reaction to the inhuman living conditions found in tenement structures in major cities.

Room dimensions, requirements for natural and mechanical ventilation,

and requirements for the insulation from sound transmission are contained in article 5. It is interesting to note the difference between the very serious public health considerations that were responsible for this kind of regulation a century ago and the somewhat lighter urgency that justifies the need to regulate sound transmission.

Article 6: Requirements for the Provision of Egress

The most obvious task that faces the designer concerned with the safety to life is providing for a timely evacuation from a structure in the event of fire. The *Building Exits Code,* promulgated by the National Fire Protection Association, was the first attempt to prescribe a "rational" system of design for the evacuation of the population of a building. Over the years, fires with a significant loss of life have been investigated, and the lessons learned have been incorporated in the subsequent editions of the code.

The *Building Exits Code* is now called the *Life Safety Code* and may have the distinction of being one of the most widely adopted regulations in the history of the world. (Ranking with it, is the National Electrical Code (also promulgated by the NFPA), which is used worldwide. Most of the requirements set forth in article 6 of the code were derived from the design concepts pioneered by the NFPA.

Article 7: The Structural Aspects of the Building

As mentioned above, structural principles were once an aggregate of "rules of thumb." With the development of modern engineering techniques and with advances in materials science, we have developed a system whereby the designer assumes a set of "loading conditions" and designs to meet them using *accepted engineering practice.* Article 7 is written primarily for the designer, that is, the registered architect or engineer.

Article 8: The Materials of Construction

When there is a question that concerns a material of construction, article 8 is the one to consult. It contains details regarding steel, concrete, masonry, timber construction, frame construction, the use of wood laminates, and other common building materials.

Materials are regulated to ensure that they have the proper structural properties and are sufficiently durable and free from defects or fire hazard. Much of article 8 is written for the designer or the laboratory technician.

The manufacturer and the specification writer may need to be familiar with the American Society for Tests and Materials (ASTM) standards listed

in the appendices of the code. These standards involve formal testing procedures, a sort of cookbook of laboratory experiments to be performed on construction materials.

Article 9: Features of Fire-resistive Construction

This article contains detailed specifications for the construction of *fire walls, fire separation walls,* and *penetrations of rated assemblies* such as doors or windows. Details are also supplied for the erection of fire-resistive *vertical shafts, roof structures,* and *firestopping* and *draftstopping.* Details on *interior finish* (flame spread) requirements and limitations on combustible finish and trim are supplied here as well.

It is useful to think of this article as providing supplemental details for requirements that are stated in other parts of the code. If a *2-hour fire wall* is specified, for example, in Table 214 of the code, article 9 will provide the details.

Article 10: Chimneys, Flues, and Vent Pipes

Ever since fire has been used inside buildings, there has been a need to safely exhaust smoke and other products of combustion. The prohibitions against thatched roofs in colonial America were predicated on the vulnerability of this type of roof construction to the ignition of fire by an airborne cinder. The prohibitions against wooden and plaster chimneys typically found in the earliest municipal building codes were instituted to prevent the sometimes disastrous consequences of chimney fires. The requirements for spark arresters, which date back to this period, are still contained in contemporary codes. The Massachusetts Building Code recognizes three types of chimneys: Factory-built chimneys, masonry chimneys, and metal chimneys (smokestacks). This article addresses the appropriateness of the chimney to the appliance served, the types of chimneys used, the dimensioning of flues, and the use of multiple flues and multiple fuels.

Article 11: Mechanical Equipment and Systems

The code briefly addresses some general issues involving fire protection in boiler rooms, drying rooms, refuse chutes and vaults, and refuse conveyor systems. More detailed requirements are found in the BOCA Mechanical Code listed in appendix B of the code. Mechanical equipment designers are usually familiar with this appended code. Nevertheless, it is well to remember that the *edition* of the mechanical code consulted for design purposes may be critical in matters of detail. In the original fourth edition of the code,

appendix B specified the 1978 edition of the BOCA Mechanical Code; a subsequent amendment to the Massachusetts State Building Code has changed this reference to the *1987* edition of the BOCA Mechanical Code, which is currently the proper document to consult for design issues.

Article 12: Fire Protection Systems

There are two types of fire protection systems: *suppression systems* actively fight fire, and *detection systems* merely detect a fire condition and signal to indicate the condition. Article 12 identifies where systems are required and provides some guidance to the designer in selecting a system.

Fire Suppression Systems

Fire suppression systems are required by section 1202 of the code in the following areas or circumstances:

1. In *unlimited area* buildings (§ 1202.13 and § 307)
2. In *windowless stories:* that is, in every *story or basement* where there is not provided at least 20 square feet of opening entirely above the adjoining grade level for each 50 lineal feet of exterior wall, unless there is an exterior stairway conforming to the provisions of § 619.0 in each 50 feet of lineal wall on at least one side of the building (§ 1202.15)
3. Storage and workshop areas (§ 1202.14)
4. Painting rooms (§ 1202.16)
5. Trash rooms and chutes (§ 1202.17)
6. Boiler or furnace rooms (§ 1202.18)
7. Unenclosed vertical openings (§ 1202.19 and § 437.31)
8. Kitchen exhaust systems (§ 1202.20)
9. Hazardous exhaust systems (§ 1202.21)
10. In high-rise buildings (§ 1202.6 and MGL c148 § 26A)

Additionally, suppression systems are required in a number of occupancy groups that satisfy certain dimensional conditions.

Whether required for height or area, or when optional (to gain other numerous *trade-off concessions* allowed for suppression), all sprinkler sys-

tems must be installed and maintained in conformance with the provisions of NFPA 13, as referenced in appendix I of the code.

Detection Systems

Section 1218.3 requires that an *automatic fire detection system* be installed and maintained in accordance with NFPA 72E in *use groups* I, R, and B, which meet the conditions specified in § 1218.3.1–§ 1218.3.5. Buildings so required, but which are equipped with an automatic suppression system, are exempt from the requirement for detection systems but are required to be equipped with a manually operated alarm system (called "pull stations") conforming to the provisions of § 1217.0 of the code.

Article 13: Precautions During Building Operations

There is no esoteric language in this article, no engineering jargon, and no highfalutin high-tech concepts. This article contains plain common sense, addressing the issue of safety at the construction site. Because the protection of workers is a primary responsibility of the supervisor, licenced construction supervisors should have a thorough familiarity with the provisions of this article.

Section 1300.2 requires that any issues concerning operational safety that are not specifically addressed in article 13 of the code are governed by the provisions of 441 CMR 10.00 Rules and Regulations for the Prevention of Accidents in Construction Operations, and 527 CMR 13.00 Rules and Regulations for Keeping, Storage, Use, Manufacture, Sale, Handling, Transportation, or other Disposition of Explosives.

Article 14: Signs

Signs are usually more strictly governed by the local zoning ordinance than by the state building code, which concerns itself primarily with issues surrounding the structural stability and anchorage of the signs. Because both the Constitution of the United States of America and the Constitution of the Commonwealth of Massachusetts constrain legislatures in matters that involve the abridging of freedom of speech and expression, code writers who engage in the drafting of this kind of legislation need to be extremely circumspect. For the same reasons, citizens should be ever vigilant and tenaciously critical of measures of this type.

Articles 15 through 17

Article 15 requires that electrical wiring be installed, repaired, and maintained in accordance with the Massashusetts electrical code (527 CMR 12.00).

Article 16 requires that elevator, dumbwaiter, and conveyor equipment be installed in accordance with the appropriate state regulations (524 CMR 15.00 through 33.00).

Article 17 requires that the installation of plumbing and gas fitting be in accordance with the appropriate state regulations (248 CMR 2.00–8.00).

Article 18: Manufactured Buildings, Building Components, and Mobile Homes

Article 18 is written for the manufacturer and contains procedural requirements for certification. According to Dodge Construction statistics, the majority of permits being issued for single family detached wood frame dwelling structures are for manufactured buildings. Those readers interested in this article will also want to consult Section 111.4 (see page 13), as well as appendix Q(mb) entitled "Rules and Regulations for Manufactured Buildings, Building components, and Mobile Homes" (see pages 772–806 of the code).

Article 19: Light-transmitting Plastic Construction

It is a fundamental principle of safety engineering that high energy systems, whether they consist of high concentrations of kinetic energy, for example, a bullet or a moving automobile, or high concentrations of potential energy, for example, a keg of dynamite, are inherently hazardous. Because of the high energy content of light-transmitting plastic materials, the code requires testing the materials in conformance with a number of ASTM standards that address issues such as *ignition properties* and *smoke development*. In addition, the code regulates plastic glazing in fire rated separations, and the structural properties of plastic glazing used in skylights, roof panels, awnings, and similar structures.

Greenhouses (§ 1901) used for agricultural purposes are exempt from the structural requirements of the code pursuant to a Massachusetts Special Law: An Act Exempting Certain Greenhouses from Provisions of the State Building Code (chapter 671 of the Acts of 1983).

Article 20: Provisions for Energy Conservation

A principle in paleontology known as "Rommer's rule" holds that an organism that develops a new structure will tend to develop it out of existing tissue. Organizations as well as organisms display this principle. In the early 1970s when the federal government sought to influence the consumption of fossil fuel–based energy for heating purposes, the building codes throughout

the country were immediately seen as the proper vehicle for implementing a policy of conservation. There are some legitimate challenges which can be made to the inclusion of energy conservation regulation in the building code. It is arguable that this kind of legislation has so little direct connection with issues of public safety that the regulations do not deserve to be enforced under the police powers of the state. As with regulations governing signs, a vigilant and ornery citizenry needs to contain the expansion of the police powers into areas where their legitimacy is questionable.

Article 20 lists three methods for achieving compliance: (1) by component design, (2) by systems analysis, and (3) by the use of nondepletable energy sources. Additional requirements governing the efficiency of HVAC systems, power lighting limitations, and building temperatures are also included.

Article 21: The Construction of One- and Two-Family Dwellings

Unlike the rest of the code, which utilizes, for the most part, *performance standards*, article 21 is a *specification code*. The basic fabric of this article is the CABO One- and Two-Family Code, which is mentioned above on page 9. The specifications in article 21 are not mandatory. A designer has the option to design in accordance with the general provisions of the code.

Article 22: The Repair, Alteration, Addition, and Change of Use of Existing Buildings

Building inspectors in the older communities in this state will freely admit that most of the activity in their jurisdiction is governed by article 22.

As mentioned in chapter 1 of this book, most of the provisions of the state building code were developed by the major code writing organizations. Article 22 of the code represents an original effort on the part of the Massachusetts regulators to recognize the difficulties in "retrofitting" an existing building to conform to all the code requirements for new construction. Nevertheless, it is quite possible to conform to the intent of the code by providing a system whereby the heights and areas of buildings are regulated, adequate egress provided, and the significant hazards to life safety are mitigated.

Article 22 also provides a structured system for evaluating risk and selecting compliance alternatives.

THE APPENDICES

Most people ignore appendices. Those who do deprive themselves of a great deal of useful information. In the following section, we review the appendi-

ces of the code and identify sections that will be particularly helpful to code readers.

Appendix A: Reference Standards Agencies (pages 698–700)

This appendix merely lists those agencies that develop standards to which the code frequently refers. References throughout the code make use of the acronyms for these agencies. When an unfamiliar acronym is encountered, appendix A can be used for decoding. The agency name and mailing address are included.

Appendix B: Accepted Engineering Practice Standards (pages 701–8)

The phrase "accepted engineering practice" is not a licence for a designer to try anything that a registered professional is willing to stamp with an official seal. Professional designers are required to perform in accordance with the standards of the profession, and appendix B presents some of these standards. Readers should pay particular attention to the numbers following each standard. These indicate the "edition" or the year in which the standard was published. It is wise not to assume that prior editions or subsequent editions are equally acceptable. Any questions concerning the proper edition should be referred to the *authority having jurisdiction*.

Appendix C: Material Standards (pages 709–718)

It is useful to think of this appendix as belonging to article 8, which governs materials. Many of the materials used in building construction are regulated at the manufacturing stage. Most of the standards enumerated in this appendix are those of the American Society for Tests and Materials or the American National Standards Institute. The test procedures described in appendix C are primarily of use to the laboratory technicians employed by the manufacturer or the independent testing laboratory.

Appendix D: Structural Unit Test Standards (pages 719–720)

These are similar to the standards in the previous appendix, except they apply to structural "units."

Appendix E: Structural Assembly Test Standards (page 722)

These are similar to those of the previous two appendices, except they apply to structural "assemblies."

Appendix F: Durability Test Standards (page 723)

Again, this appendix contains standards similar to the previous ones, except these address the issue of the "durability" of the materials.

Appendix G: Fire Test and Flame Spread Test Standards (pages 724–725)

These standards address the performance of materials in terms of fire safety. It is useful to think of this appendix as belonging, in part, to article 9 of the code.

Appendix H: Standard Time-Temperature Fire Test Controls (page 726)

These figures are used in the application of the fire penetration test (ASTM E119-76) listed in appendix G.

Appendix I: Fire Protection Standards (pages 727–728)

These standards apply to fire protection equipment, and most are promulgated by the National Fire Protection Association or the Underwriters Laboratories.

Appendix J: Unit Dead Loads for Design Purposes (pages 729–736)

This appendix will be particularly useful in estimating the *dead load,* or the weight of a structure. Common building materials are listed together with weights per square or cubic foot.

Appendix K: Unit Working Stresses for Ordinary Materials (pages 737–740)

This appendix gives the structural designer direction by providing information concerning the assumed working stresses for common construction materials.

Appendix L: Procedure for Accounting for Series and Parallel Heat Flow Paths (pages 741–741.2)

This appendix outlines a computational procedure used in making the computations specified in § 2008.2 of the code. These computations involve the thermal performance of building envelopes and sections.

Appendix M: Recommended Nailing Schedule (pages 742–744.1)

This appendix will be useful to the craftsperson in the field or the specification writer. It contains nailing schedules for construction assemblies. See also Table 2103–2 (pages 572–73) for fastener schedules for one- and two-family dwellings.

Appendix N: Metric Equivalents (page 745)

This appendix is regarded with amusement as, in Oscar Wilde's words, "A triumph of hope over experience." From the evidence, this appendix will become useful when Hell freezes over.

Appendix O: Accredited Authoritative Agencies (pages 746–53)

This appendix contains the names and mailing addresses of a multitude of agencies that provide authoritative information concerning methods and materials of construction.

Appendix P: Specialized Massachusetts Rules and Regulations Other Than State Building Code Commission (pages 754–57)

Contained in this appendix is a list of regulations governing aspects of construction projects that are promulgated by other state agencies. Note: the State Building Code Commission is now called the State Board of Building Regulations and Standards.

Appendix Q: Massachusetts State Building Code Commission Rules and Regulations (pages 758–821)

It is understandable that there are some issues the Commonwealth of Massachusetts regards as local issues with a need to prescribe specifically therefor. This appendix is divided into six parts:

1. Rules and regulations for licensing of concrete testing laboratories (pages 759–66)

2. Rules and regulations for concrete testing personnel (pages 767–71)

3. Rules and regulations for manufactured buildings, building components, and mobile homes (pages 772–806)

4. Rules and regulations for controlling the use of native lumber (pages 807–10)

5. Rules and regulations for licensing construction supervisors as defined in section 109.1.1 of the Massachusetts State Building Code (pages 810.1–810.8)

6. Rules and regulations for the accreditation of testing laboratories to test solid fuel heating appliances (pages 811–21)

Appendix R: Technical Code Council (page 822)

Members of the Technical Code Council meet at periodic intervals to discuss conflicts between the building code and other state regulations as well as to provide a forum for suggesting revisions to the code.

Appendix S: State Building Code Commission Advisory Boards and Committees (pages 823–27)

This appendix simply lists the membership of the standing advisory committees that report to the State Board of Building Regulations and Standards.

Appendix T: Reference Data for Repair, Alteration, Addition, and Change of Use of Existing Buildings (pages 828–56)

This is an important appendix. It is regarded as a supplement to article 22 of the code, which governs the repair, alteration, and change of use of existing buildings. The four parts of appendix T cover the following:

Part 1: Guidelines for applications

Part 2: Suggested compliance alternatives

Part 3: A detailed classification of occupancy by *hazard index* and *use group*

Part 4: A method for ascertaining the *fire resistance ratings* of building materials that are not currently in common use.

Appendix U: Historic Structures (pages 857–62)

This appendix contains a list of structures that are also listed in the *National Register of Historic Places* and consequently qualify as "totally preserved buildings" within the meaning of section 436.3. (Article 4 is the special use and occupancy article and Section 436 governs historic buildings.)

Appendix V: Building Envelope Construction (pages 862.1–862.16)

This appendix contains equations, data, and tables used by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) in an attempt to develop a computer-based system for determining system performance as contained in § 2014.5 of the code. (The reference in appendix V to § 2104.5 is a typographical error—there is no § 2104.5.)

So far as I've been able to determine, no such computer-based calculating system has been developed (at least none that works correctly).

Appendix W: Reference Standards—Article 21 (pages 863.1–863.10)

This appendix is a replication of the reference standards that are incorporated in article 21 of the code. Article 21 is the *one-* and *two-family dwelling* code and lists these reference standards on pages 675–83.

Appendix X: Guidance for the Selection of Foundation Material Classes in Table 720 (pages 863.11–863.13)

This appendix is provided as a guide to the engineer who is engaged in foundation design and is confronted with making design assumptions on the basis of values listed in Table 720, which is entitled, "Allowable Bearing Pressures for Foundation Materials." The title of this table in previous editions of the code was "Presumptive Bearing Value of Foundation Materials." This appendix is not intended to be a substitute for engineering or for engineering judgment; it is offered merely as a guide.

Index (pages 864–92)

The index is always an important part of any text. Readers can use the index to locate sections of the code by subject reference. Those who use the code regularly often find themselves adding subject words and page numbers, in pencil, to the index. Readers are encouraged to develop this habit. This practice will help readers "customize" their copy of the code and will more than return the investment in time.

4

The Framework

> "Borges . . . quotes a 'certain Chinese encyclopedia in which it is written that 'animals are divided into (a) belonging to the emperor, (b) embalmed, (c) tame, (d) suckling pigs, (e) sirens, (f) fabulous, (g) stray dogs, (h) included in the present classification, (i) frenzied, (j) innumerable, (k) drawn with a very fine camelhair brush, (l) et cetera, (m) having just broken the water pitcher, (n) that from a long way off look like flies'. In the wonderment of this taxonomy, the thing we apprehend in one great leap, the thing that, by means of the fable, is demonstrated as the exotic charm of another system of thought, is the limitation of our own, the stark impossibility of thinking THAT."
>
> —Michel Foucault in *The Order of Things*

There is a basic framework to the structure of the code. To understand it, one must have an appreciation for the concepts *construction type* and *occupancy*. There are few code requirements that are absolute. Most code requirements are contingent upon the construction type and the occupancy. If we do not know, at the outset, (1) the *materials of construction* and their *fire resistance ratings*, and (2) the intended *use* of the building, we are at a loss to determine code requirements. Let us take a detailed look at *construction types* first.

CONSTRUCTION TYPES

The classification of construction types enables code writers to assign a risk value to a building on the basis of its materials of construction and the fire resistance ratings of certain structural components. In the Massachusetts State Building Code there are four construction types. A descriptive definition is supplied in article 2 of the code (the definition article, naturally), starting with Section 214 (on page 110).

Table 214 (on page 116) supplies information regarding the required fire-resistance ratings for each construction type and subtype. These are displayed in matrix form. The intersection of a row (structural element) and a column (construction type) yields a unique *fire resistance rating*.

Type 1 and *Type 2* construction consists of basically the same materials. Structural elements and building components are of "noncombustible" construction such as steel, masonry, or concrete. This does not mean they

cannot be damaged by fire or even that they perform well during a fire. It simply means that the structural elements of the building do not contribute to the fuel of a fire.

Type 3 and *Type 4* construction types are classified as "combustible," that is, structural elements and building components may be of combustible material. Basically, this means wood. The distinctive characteristics of *Type 3* construction are 1. the exterior walls are of masonry, and 2. the other structural elements are of wood. *Type 4* buildings are of wood frame construction without exterior walls of masonry.

❖

REVIEW

Type 1 and Type 2 construction contain noncombustible structural elements.

Type 3 construction contains combustible structural elements but with exterior walls of masonry.

Type 4 construction contains combustible structural elements (light wood frame).

Sub-Types

Each type of construction is further subdivided into subtypes, which are designated by letters following the construction type number. To understand the subtypes, it is helpful to look at *Table 214* (on page 116). We will provide a mental picture of the construction types and subtypes. Let's start with *Type 3*.

Type 3, as we mentioned, is characterized by exterior walls that are of masonry construction. This category is further broken down into three subtypes, namely, *Type 3A*, *Type 3B*, and *Type 3C*.

Type 3A

Type 3A, what we call "mill construction," has exterior walls made of masonry and structural elements made of wood. It differs from *frame* construction in that the wood is *heavy timber* as opposed to *light framing* which uses *dimensioned lumber*. The size of the structural timbers (the cross-sectional area) is significantly greater than structural considerations alone would require. When heavy timber is used, the framing does not have "concealed spaces." It is presumed that the enlarged size of the framing members, together with the absence of concealed spaces, produces a building with a different kind of risk to fire damage than a conventional

framed building. Those of us in New England are well acquainted with this kind of construction. Our cities and many of our small towns grew dramatically during the Industrial Revolution, and for many communities the largest examples of local architecture of that era are the old mill buildings.

Largely because of the efforts of the Boston Manufacturers' Mutual Fire Insurance Company, local companies, in order to qualify for insurance coverage, began to erect mill buildings according to a system of rules that were designed to minimize the potential for fire loss. Large timbers were chamfered to reduce the probability that they would ignite. Each floor was separated from adjacent floors with fire stops to minimize the probability of the vertical spread of fire. Stairways and shafts were enclosed with brick. The joisting was precut (or "fire cut," as it was called) to facilitate the collapse of the floors without bringing down the walls. The "fire wall" was developed at this time in order to compartmentalize each floor and present further barriers to the spread of fire, and the fire wall was structurally independent, that is, capable of collapse on either side without causing collapse on the opposite side. These design constraints represent the first comprehensive attempts to design buildings to perform in a predictable way in the event of fire.

What about heavy timber construction without masonry walls? For the time being, it will be classified as wood frame construction (Type 4). Recent revisions of the model codes offer five construction types. The additional category is heavy timber construction, with or without exterior masonry walls. This change, however, has not yet been incorporated into the Massachusetts State Building Code.

Type 3B

Type 3B construction is also known as "protected ordinary" construction. The word "ordinary" refers to ordinary joisting. The building is basically a light wood frame building enveloped in an exterior masonry wall. The term "protected" indicates that certain components and structural elements of the building are "protected" in such a manner as to afford a *fire resistance rating,* which is detailed in Table 214. The row house buildings on Beacon Hill, in the Back Bay, and in the South End are all *ordinary construction.* One might be *protected* and the next one in line might be *unprotected.* One would be able to say for sure only after a detailed investigation of the interior of the building.

Type 3C

Type 3C construction is also known as "unprotected ordinary" construction. As mentioned above, this construction is exactly the same as Type 3B, except that it does not have the required fire resistance ratings. Type 3C might have adequate fire resistance ratings on *some* of the components, but

to be classified as Type 3B, the construction must have the full set of required ratings. Anything short of compliance to the specifications for Type 3B is classified as Type 3C.

❖

REVIEW

Type 3 **construction is characterized by exterior masonry walls.**

Type 3A **is mill construction, distinguished by the use of heavy timber for structural elements.**

Type 3B **is *protected ordinary* construction, distinguished by the use of dimensioned lumber (light framing) and fire protection ratings in accordance with Table 214.**

Type 3C **is *unprotected ordinary* construction, distinguished also by light framing and by the absence of fire protection ratings on structural elements.**

Type 4A

Type 4A construction is also known as "protected wood frame" construction. Structural elements consist of light dimensioned lumber (2x4s or 2x6s, and so forth) or light timbers.

The use of light dimensioned lumber became popular in the mid-nineteenth century. *Balloon framing* is believed to date from the erection of Saint Mary's Church in Chicago in 1833. In the first major improvement in framing since medieval times, light members were arranged in a structural gridding pattern or "cage" and were braced laterally to provide rigidity. The gossamer arrangement of structural elements reminded many of a balloon; thus its name.

The modern adaptation of this form of framing is called "platform" framing. Studs are limited in length to the height of a single floor and are secured at top and bottom with a sole or sill plate. This new method has simplified the task of erecting walls and has supplied fire stopping at each floor as well.

As mentioned above, the term "protected" refers to the *fire resistance ratings* supplied for certain structural elements and building components detailed in Table 214.

Type 4B

Type 4B construction is also known as "unprotected wood frame" construction and is perhaps the most common construction type. The typical single-

family detached wood frame house is of this construction type. Structural elements are of light dimensioned lumber as in Type 4A, but the requirements for fire resistance ratings apply only to exitways and separation from other buildings or occupancies. A wood frame building without the fire resistance ratings needed to qualify for Type 4A is classified as Type 4B.

Now let's try to a provide a mental picture of the "noncombustible" construction types.

Type 2C

We start with Type 2C because it is the easiest to visualize. Type 2C is also known as "unprotected non-combustible" construction. The structural elements are made of noncombustible materials (that is, steel, masonry, or concrete). As in Type 4B, there are no requirements for fire-resistive protection of the structural elements of the building. Fire-resistive requirements apply only to egress components and to the separation of occupancies. In this Type 2C, we are likely to see exposed steel columns, bar joists, or other structural elements. Many of our supermarkets, shopping malls, and industrial buildings are of this construction type.

Everything Else

Type 1A, Type 1B, Type 2A, Type 2B

Type 1 used to be called "fireproof," but because no building is fireproof, this term has been purged from most current building codes. Type 2 buildings are called noncombustible. The most recent edition of the BOCA code uses the word "noncombustible" to refer to both Types 1 and 2. All of these construction types are basically the same materials. They are all "noncombustible," and they all have fire resistance rating requirements for structural elements. They differ only in the severity of the fire-resistive ratings required. A glance at Table 214 will reveal this.

Notice, for example, that interior bearing walls, bearing partitions columns, girders, trusses, and framing, (item 8 in the left-hand column of Table 214) supporting more than one floor have required fire-resistive ratings of 4 hours for Type 1A, 3 hours for Type 1B, 2 hours for Type 2A, and 1 hour for Type 2B.

Remember that these construction types are *definitions*, which is why they are detailed in article 2. They are *not requirements*. Requirements will come later. For now, it is imperative that we *classify* the building according to its construction type.

Buildings need two classifications: the construction type indicates the manner in which the building is constructed, and the second classification,

which we call the *occupancy type* or *use group classification*, indicates the manner in which the building will be used. Each occupancy has its own distinctive set of hazards, some severe, some not, some use groups (storage, for example) are hazardous but are not occupied by people.

In examining the occupancy classifications as set forth in the building code let's see if we can identify their distinctive features. Before we do, a word about "hazards."

A hazard is something different from a dangerous condition or even a code violation. The word "hazard" refers to an intrinsic property. For example, a motor vehicle is hazardous. It can be operated safely, but the enormous weight and the substantial energy required to move that weight combine to produce a hazardous amount of momentum. High concentrations of electrical energy, (power supply and so forth) or chemical energy (corrosive, reactive, toxic, or flammable) or radiant energy (including exposure to the sun) are all presumed to be hazardous. It is not the intent of the code to eliminate hazards, (this would be naïve); rather the code attempts to manage hazards. Fire safety regulations, for example, are designed to minimize the probability of a fire incident, and to minimize the impact of a fire.

We have reviewed some of the hazards that are inherent in the physical building, now we look at some of the hazards that are inherent in the manner in which a building is used.

USE GROUPS

Use group or occupancy classifications enable code writers to assess risk on the basis of activity. In the Massachusetts State Building Code there are nine categories that are mutually exclusive and exhaustive of all activity within buildings. This means that all activity is classified in one, and only one, of these groups. It is useful to know all of these classifications as well as to have a sense of the unique risks involved in each occupancy. Following is a discussion of the distinctive features of the occupancies, or use groups, and the design problems and regulatory characteristics unique to each classification.

Use Group A: Places of Assembly

Places of assembly are characterized by high density occupant loads. An occupancy load of fifty persons or more is required for a building to belong in this category. Uses that would otherwise qualify but are occupied by fewer than fifty persons, will be classified in use group B (business). Typically, the occupants in Use Group A have minimum familiarity with the

surroundings. The potential for panic is at a maximum, and historically, there is a reasonably high probability of incident.

This classification is subdivided into six subgroups, each with its distinctive forms of risk.

Use Group A-1: Theaters

There are two kinds of theaters:

A-1-A Stage theaters. These will contain a raised platform stage and proscenium, a scenery loft, lighting apparatus, and other theatrical accessories. Seating will be fixed.

A-1-B Motion picture theaters. These will contain a motion picture screen without a stage or proscenium. Here also, seating will be fixed. Remember, as in all of the assembly categories, if these uses have an occupancy load of fewer than fifty persons, the occupancy should be classified under Use Group B (Business).

Use Group A-2: Night Clubs and Similar

Use Group *A-2* is the classification for nightclubs, dance halls, and similar uses with an occupancy load of greater than fifty persons. These are oftentimes occupied with extraordinary density, and the frequency with which licenses to serve alcohol attend this occupancy makes it reasonable to assume something less than full capacity for self-preservation on the part of the occupants. Frequently, occupants are unfamiliar with their surroundings, and the potential for panic has been demonstrated in a number of tragic events. The Coconut Grove Restaurant was classified as Use Group A-2. This classification has received a considerable amount of attention from code writers since the fire of November 28, 1942, in which 492 people lost their lives.

Use Group A-3: Amusement, Entertainment, or Recreation

Use Group *A-3* includes places where people assemble for the reasons listed, excluding theaters, nightclubs, and so forth, which we have already classified. Certain of the "trappings" of the previous categories are allowed, (raised platforms, for instance) provided that they are "incidental." This use group is the "wastebasket category": Anything that does not fit the other definitions gets classified as Use Group A-3.

Use Group A-4: Churches and Schools

Attendants at church or school are presumed to be alert. The solemn nature of activities conducted therein is seen to minimize the risk of panic. Both occupancies are expected to contain people varying widely in age and physical capacity for self-preservation, including the very young, the el-

derly, and the physically handicapped. The risks are similar; these occupancies are therefore classified together in Use Group *A-4*.

Use Group A-5: Outdoor Assembly, Stadia, Grandstands

Structures as opposed to merely *buildings* are regulated by the code. For those uninitiated in the distinction between these terms, a quick detour to the definition section, article 2 of the code, is in order (see page 44 for "building" and page 77 for "structure").

There are structures that are not buildings but that contain an occupant density sufficient to be classified as a place of assembly. Because the structures are unenclosed, the danger inherent in the buildup of heat, smoke, and other products of combustion is minimal. Historically, however, this occupancy is not without incident, and the enormity of the occupancy loads of some structures (Sullivan Stadium, for example, has an occupancy load of 61,000 persons and Fenway Park, 17,000) is sufficient to make the consequences of panic quite serious.

Use Group B: Places of Business

Places used for the transaction of business or the rendering of professional services are generally occupied by alert people who are familiar with their surroundings. They are seldom occupied at night and are known for low combustible loading. Limited stocks of goods and merchandise incidental to this use are allowed. Business occupancies are not as highly regulated as, say, places of assembly, residential, or even mercantile occupancies. Business is, in fact, the least highly regulated occupancy group, which accounts for the fact that some of our tallest, largest, and most daring experiments in architecture are found in this use group.

Use Group F: Factory and Industrial

Places in which products or materials are fabricated, assembled, or processed are classified in Use Group F. It is obvious that the attendant use of electrical power, combustion, and/or mechanical equipment and the use and storage of volatile or otherwise dangerous chemicals combine to create a hazardous milieu. On the other hand, occupants are presumed to be alert and familiar with their surroundings, industrial buildings are usually separated from other uses by zoning restrictions, and in most factories there are operational programs that specifically address safety issues including fire safety.

Use Group H: Places of High Hazard

Facilities in which highly inflammable, explosive, toxic, or reactive materials are stored or used are classified in Use Group H. This is the most strictly regulated occupancy classification, for obvious reasons. Table 206.2 (on page 93 of the code) contains a varied, but not exhaustive, roster of activities that are appropriately classified in this use group.

It requires something beyond the layman's command of fire history to recognize uses that would fall within this category, because the common perception would focus on industrial activity. Yet the storage and processing of cereal grains, fruit ripening, and the pulverizing of sugar or starch products are included in this occupancy classification as well.

Use Group I: Institutional Occupancies

Institutional occupancies are distinguished because the occupants are likely to be incapable of evacuating the building under emergency or stressful conditions because they are either restrained or incapacitated or both. Consequently, the requirements for "compartmentation" are more severe, reflecting the "defend in place" design concept. This occupancy group is subdivided into two subcategories.

Use Group I-1: Institutional Restrained

Jails, prisons, and facilities for the mentally infirm have in common the practice of restraining the occupants against egress. Lacking provision for this most fundamental feature of firesafe design, these facilities are required to compensate by providing other types of protection in order to assure safety to life. Fire-resistive compartmentation, suppression systems, and limitations on combustible construction and furnishing are the favored methods.

Use Group I-2: Institutional Incapacitated

There is little difference in the ultimate risk between those that are restrained because it is intended that they be restrained and those that are restrained because of physical limitations due to age or incapacity, dependency on life support systems, or the effects of medication. Here, also, the "defend in place" design concept is invoked.

Designing for life safety in both of the *institutional* occupancy classifications involves complex analysis of interactive safety systems ranging from the physical plant to operational features such as fire drills and maintenance schedules. These occupancies are highly regulated, they involve compliance

with a variety of additional codes, and frequently they require the attention of design specialists.

Use Group M: Mercantile Occupancies

Mercantile occupancies differ from business occupancies in two respects. First, the *combustion load* is likely to be considerably greater. The goods and wares of the merchant are presumed to have a higher combustible content than the furnishings and equipment found in an office. Second, the *density* with which people occupy a mercantile setting is presumed to be considerably higher. Moreover, the occupants are not presumed to be as familiar with their surroundings as are those occupants of a building used for business purposes. On the risk scale, the Use Group M falls somewhere between a *business* and a *place of assembly*.

Use Group R: Residential Occupancies

One wouldn't think so, but residential occupancies are the most dangerous occupancies. This group has in common with the *institutional* occupancies the fact that the occupants sleep on the premises and are therefore not uniformly capable of self-preservation during emergency conditions. The stringency with which these occupancies are regulated is a function of the degree of transience of the occupants, which is taken as an index of their familiarity with the building.

Use Group R-1: Residential Hotels

This group includes hotels, motels, detoxification facilities, and dormitory buildings arranged for the sleeping accommodation of *more than twenty occupants*.

Use Group R-2: Residential Multiple Family

This group includes dwellings with more than *two units* and includes dormitories, boarding and lodging houses arranged for the sleeping accommodation of *fewer than twenty occupants*.

Use Group R-3: Residential

This group includes *one- or two-family dwellings* inclusive of boarding facilities. *Three or fewer boarders* are allowed in a unit for the purpose of this classification.

Use Group R-4: Residential

This group includes *detached* one- or two-family dwellings with no more than *three boarders* per unit.

Use Group R-5

This group includes *limited group residences* described as "special occupancy" in article 4 of the code.

Use Group S: Places of Storage

Although buildings used for storage usually have a high *combustible loading,* they are seldom occupied for extended periods of time by people. Regulations governing this occupancy are intended primarily to limit the size and spread of fire.

Use Group S-1: Storage

This classification is appropriate for *moderate hazard* storage. Examples of goods, wares, and merchandise that fall into the moderate hazard classification are found in Table 210.2 of the code.

Use Group S-2: Storage

Sometimes the goods, wares, and merchandise stored is of such low combustibility that it is classified as *low hazard storage.* This classification is less stringently regulated than Use Group S-1. Examples of low hazard materials are given in Table 210.3 of the code.

Use Group T: Temporary and Miscellaneous

This group includes structures that are not intended to be permanent such as tents, air-supported structures, pavilions, and so forth. In accordance with the provisions of Section 314, permits for uses within this classification are issued for a period not exceeding *one year* and may, at the discretion of the approving authority, be extended for one additional year.

Doubtful Use Group

Section 212 (on page 110) provides for the classification of uses that do not exactly conform to the definitions of the use groups. The building official is instructed to classify the occupancy in the use group that it most nearly resembles with respect to fire hazard and risks to life safety.

Mixed Use and Occupancy

Oftentimes a building will be used in such a manner that it will conform to two or more use group classifications. We are instructed (in section 213 on page 110) to treat this eventuality in one of three ways:

1. Classify the entire building in the use group that is most stringently regulated. This option requires that all provisions that apply to the most restrictive classified occupancy are enforced.

2. Separate the mixed uses horizontally and vertically with fire separation assemblies conforming to the ratings specified in Table 902 and use the most restrictive height and area limitations for the entire building. This option subjects the building to the height and area restrictions that apply to the most severely limited occupancy type, but within the separated areas, only the regulations appropriate to the classified occupancy apply.

3. Separate the mixed uses horizontally with fire walls. Since buildings are defined as "located within exterior walls or fire walls," this method of separating occupancies creates more than one building. In this option the enclosure within fire walls is sufficient to classify each segment as a separate building. Each separate building will be subjected to the full range of regulations appropriate to its classified occupancy.

Classification the Easy Way: Using Appendix T

Every building permit application requires that the occupancy group (or groups) be identified. Subtle distinctions in the nature of the activity can make this task difficult. There is both a "hard way" and an "easy way" to determine the appropriate classification for a given activity. The hard way involves pouring over the definition section with the persistence of a Talmudic scholar and drawing the sometimes fine distinctions in both the intent and the wording of the definitions. The easy way involves simply consulting appendix T of the code.

Appendix T was actually written to simplify the problems inherent in the repair, alteration, addition, or change of use of an existing building. Although this kind of project is governed by article 22, appendix T contains a wealth of information that is likely to be useful in such projects. Table T-1 can be useful in any project, even if it involves a new building.

Table T-1, which is entitled "Hazard Index and Use Group Classification," provides two kinds of useful information. First, it rates occupancies according to risk as perceived by code administrators on a scale of 1 to 8. The *hazard index number* one (1) represents a low level of hazard, whereas the *hazard index number* eight (8) represents a more severe level of hazard. In the eight pages that constitute the table (pages 835–835.8), nearly anything that one could possibly imagine doing in a building is listed in the left hand column. The center column contains the *hazard index number* and the last column contains the *use group classification*.

Here is a method for determining the proper use group without any

exercise of the imagination. One needn't think too hard about it, just look it up in *appendix T.*

HEIGHT AND AREA LIMITATIONS

We now come upon the purpose of classifying buildings according to *construction type* and *occupancy*. The first consideration that confronts a plans examiner in evaluating a building for code compliance is gauging the limitations on *height* and *area*. The task of the plans examiner is to determine that the *height* and the *area* of the building are within the limitations set by Table 305 (pages 122–23).

Area

The *area* of a building is the area within exterior walls (or fire walls). This is easiest to conceive if we think of the area of the building as viewed from a helicopter. This is oftentimes referred to as the building's *footprint*.

Many buildings exceed one story in height. If all floor areas are identical, the *total floor area* is computed by multiplying the *footprint area* by the *number of stories*. If floor areas are irregular, the *largest floor area* multiplied by the *number of stories* gives a reasonable approximation of the total floor area.

Footprint area should not be confused with *total floor area*. The area limitations specified in Table 305 refer to the *footprint* area.

Height

Height is the vertical distance from the grade to the top of the highest roof beams, or to the mean level of the highest gable (§ 201). It is within this meaning of "height," that the height limitations enumerated in Table 305 of the code apply.

The code defines "first story" as the "lowermost story entirely above the grade plane" (§ 201) and distinguishes *story* from *cellar* or *basement*. A *mezzanine* is a floor area that is located between stories, and is sized less than one third of the floor area of the floor below. A *penthouse* is defined in the same way as a mezzanine except that a penthouse is located above the roof line rather than between stories. As long as mezzanines and penthouses are dimensioned properly, they are not counted as additional floors.

Tabluar Height and Tabular Area

Table 305 of the code gives us a picture of the regulatory framework at a glance. For a given *construction type* and a given *occupancy group* there is

a unique height and area limitation. These are called the *tabular height* and *tabular area,* respectively. These limitations were developed by reviewing historical fire loss data in the United States. The rationale behind the establishment of these limitations is empirical rather than theoretical. Buildings whose dimensions are kept within these limitations are not presumed to be "absolutely safe," rather, they are on the "right side" of the statistics. That is, for buildings within these limits, the probability of significant fire loss is reasonably low and represents an *acceptable risk.*

The *tabular height* is not an absolute limitation, instead it is modified in subsequent sections of the code, where the regulations make further allowances based on the use of suppression systems.

The *tabular area* is also modified by subsequent sections of the code. It is *decreased* as a function of the number of stories, and it can be *increased* as a "trade-off" measure for the use of suppression systems and/or accessibility for the Fire Service.

Suppression indicates the existence of a sprinkler system. "Full suppression" of a building means that the system is installed in accordance with the provisions of NFPA 13.

Height Exceptions

Section 308 of the code gives three exceptions to the *tabular height* figure:

§ 308.1 allows a building in any occupancy group except *high hazard* [Use Group H] to be erected one story or 20 feet higher than the *tabular height.*

§ 308.2 allows *auditoriums* [Use Group A-4] of Type 3A construction to be erected to a height of 65 feet. Auditoriums of Type 2C, Type 3C, and Type 4B (all unprotected types) are allowed to be erected to a height of 45 feet.

§ 308.3 excludes roof structures (such as tanks, air conditioning equipment, parapet walls under 4 feet in height) and rooms (such as elevator rooms or penthouses; provided that the aggregate area of all such structures is less than one third of the area of the roof) from the height computation.

Area Exceptions

The *tabular area* is *decreased* by Table 305.4 for buildings over two stories in height. For example, a building in Use Group B (business) which is of Type 2A construction would have a height limitation of seven stories and an area limitation of 34,200 square feet. If the building were to be built to the

full seven stories, the 34,200 square foot tabular area would be reduced by 25 percent, yielding an area limitation of 25,650 square feet: (34,200 − 8,550 = 25,650).

The *tabular area* of a building can be *increased* according to the provisions of Section 306 based on two criteria.

The first criterion involves situating the building so as to exceed the minimum requirement for clearance around the perimeter. If a building has more than 25 percent of its perimeter accessible to the fire service, the *tabular area* may be increased 2 percent for each 1 percent of excess frontage. This would allow a maximum of 2.5 times the *tabular area* for full (100 percent) exposure of the perimeter. *Perimeter exposure* is defined as (1) fronting on a street, or (2) fronting on other unoccupied space not less than 30 feet in width that is accessible from a street by a posted fire lane not less than 18 feet in width.

The second criterion for an increase in the *tabular area* involves a trade-off for suppression. Buildings of all use groups except Use Group H (high hazard) may increase their *tabular area* by 200 percent if they are one story in height or by 100 percent if they are higher.

Section 306.5 limits the total increase to 3.5 times the *tabular area*. This means that if we both *suppress* the building and make the *perimeter accessible,* the total area allowed cannot be more than 3.5 times the original *tabular area*.

EXAMPLE

The proposed building is a four-story office building located at XXXXXXX Road in XXXXXXXX XX. (MAP # XX, LOT # XX)

Construction type: 2C construction
Occupancy: business, Use Group B
Hazard index: 2
Footprint area: 11,625 square feet (largest floor area)
Height: four stories
Suppression: full suppression per NFPA 13

Height: Table 305 allows three stories or 40 feet in height.

ADJUSTMENTS: § 308.0 allows an increase of one story or 20 feet in height for full suppression.

Area: Table 305 allows an area of 14,400 square feet.

ADJUSTMENTS:

Tabular Area is 14,400 (Table 305).

Adjusted Tabular Area Table 305.4 requires a 20 percent reduction in area for a four-story building of Type 2C construction. ($14{,}400 \times .8 = 11{,}520$)

Area Increases

1. § 306.3 allows an increase of 100 percent in area for full suppression. (area increase equals 11,520 square feet)

2. § 306.2 allows an increase of 2 percent in area for each 1 percent of excess frontage. Frontage is defined as 30 feet of unoccupied space accessible from a public way. (area increase equals 17,280 square feet)

3. Per § 306.5 the *total area* cannot exceed 3.5 times the *tabular area* ($11{,}520 \times 3.5 = 34{,}560$)

Bottom Line: building is Type 2C construction; allowable height is four stories; allowable area is 34,560 square feet; actual height is four stories; actual area is 11,625 square feet.

5
Egress

"Go, I'll conduct you to the sanctuary."
Exeunt.
The Life and Death of King Richard III (act II)

P.T. Barnum, so legend has it, had a sign placed just inside the entrance to his sideshows with an arrow pointing to a door and, in bold print, the words "This way to the egress." The unsuspecting clientele, few of whom had studied Latin, would walk through the door expecting to see a "two-headed egress" or some other strange exhibit, only to find themselves outside and needing to pay another nickel to get back in.

"Egress" (according to *Websters Ninth New Collegiate Dictionary*) is derived from the French *egredi*, meaning to go out, which is in turn from the Latin *egressus*. *Egredi* decomposes into *e* (out) + *gradi* (walk) and is related to the word "grade."

"Exit" is from the French *exire*, which also derives from the Latin *exit* (meaning he goes out) and is related to the word "issue."

"Exeunt" is from the Latin also, meaning "they go out." It is used as a stage direction when it is intended that a group of characters leave the stage. The word "exeunt" need not be included here, because it is not currently used in codes. But it is supplied as a suggestion for revisions. It is not gender specific, and surely the plural form would seem to be the more appropriate to adorn our doorways.

THE FUNDAMENTAL THEMES OF EGRESS DESIGN

Given that the *height* and *area* limitations have been satisfied and that the proper *construction types* have been achieved, the important issues bearing on the safety to life involve conformance to regulations that address the provision of adequately designed exits. The matters affecting the capacity, location, dimensioning, arrangement, and maintenance of exits are the substance of article 6 in the Massachusetts State Building Code.

In most occupancies, the central requirements for fire safety involve the

capacity to evacuate a building under emergency or stressful conditions. Several features are involved in determining the "adequacy" of exits. I have organized code requirements under 11 fundamental themes of egress design: redundancy, sufficiency, length of exit travel, configuration, protection of egress passageways, interior finish, smoke control, hardware, illumination and signage, the dimensioning of stairs, and evacuation planning.

Redundancy

To be functional, a building must have an entrance. In most occupancies, at least two doors are required because it is possible for one to be compromised by fire. The doors are further required to be as remote as possible from each other and must provide a safe, clear, and unobstructed path to a public way. All buildings except those specified in Table 609 must have, at a minimum, two *exits* conforming to the provisions of article 6 of the Massachusetts State Building Code (§ 609). Acceptable exits include: (1) direct exits to grade, (2) horizontal exits (§ 614), (3) interior exitway stairways (§ 616), or (4) exterior exitway stairways (§ 619).

Rooms or spaces with an *occupancy load* of more than fifty persons or with an area in excess of 2,000 square feet are required to have two exits (§ 612.2).

Mezzanines with an *occupancy load* of more than fifty persons or with an area in excess of 2,000 square feet are required to have two exits, which are required to be enclosed only if the exit travel distance exceeds the limitations designated in Table 607 (§ 610.1).

Sufficiency

In some buildings, the number of people that are expected to occupy the building is too large to be accommodated by two exits. In this case, more than two exits are required. The code directs the designer to estimate the *occupancy load*, or the number of people that is expected to occupy the building. The estimate can in no case fall below the figures specified in Table 606, which is entitled "Maximum Floor Area Allowances per Occupant." These figures will be matched to the *capacity per unit exit width* specified in Table 608. The unit of exit width (UEW) is explained in the following parable:

> Traveling across the Massachusetts Avenue Bridge that connects Boston with Cambridge, one notices that the bridge is measured off in smoots and ears. The bridge measures three hundred and sixty four and four tenths smoots, and one ear, in length. 364.4 smoots plus one ear. Some M.I.T. fraternity brothers, so the story goes, got pretty sauced one night as brothers are wont to do. They grabbed one of the brothers, (whose name was Smoot), and laid him end to end, marking the distance. The measurements remain for posterity.

The *unit of exit width* is similar to a smoot. Twenty-two inches was reported to be the average shoulder width of an American soldier during World War II. Although 22-inch doors are too small to conform to the code, it is useful to think of door width in terms of the number of people that can pass through a door shoulder to shoulder. We therefore measure doors in units of exit width (UEWs).

Half of twenty-two is eleven. But building codes are a trifle kinkier in their arithmetic. Half of a unit of exit width is 12 inches. There is no quarter of a unit of exit width, no eighth, no tenth, in fact there are no divisions other than units and half units.

So, a 28-inch doorway measures 1 unit of exit width, as does a 30-, and a 32-inch doorway. A 34-inch doorway measures 1.5 units of exit width, as does a 36-, 38-, 40-, and 42-inch doorway. A 44-inch doorway measures 2 units of exit width, and so on.

Once we have measured our doorways and have computed our total number of units of exit width, we are now prepared to ascertain whether we have sufficient capacity to exhaust our occupancy through our doorways.

Table 608 (on page 219) gives us our capacity per *unit of exit width*. We must then match our *occupancy load* to our *total capacity*. Our capacity must equal or exceed our occupancy load. Notice that the *spanner* is divided into two cases, (one for buildings with a fire suppression system and another for those without. Each case contains two column heads, one for stairways and one for doors, ramps, and corridors.

EXAMPLE Suppose we are in a place of *assembly*, there are two doors leading directly to the outside, each measuring 38 inches in clear width. The building is not suppressed. How many people can safely occupy this place?

Answer: Each door measures 1.5 UEWs
There are two doors: 2 times 1.5 = 3 UEWs
Table 608 indicates that we can safely evacuate 100 persons per UEW.
We can therefore occupy this building with 300 people.

❖

REVIEW OF OCCUPANCY LOAD and EGRESS CALCULATIONS

1. Table 606 gives maximum floor area per occupant for a business occupancy, at 100 square feet/person.

2. Table 608 gives capacity per UEW for *suppressed* buildings of business occupancy at 113 for *stairways* and 150 for *doors, ramps,* and *corridors*.

Floor areas and occupancy loads are as follows:

Floor number	Floor area (in square feet)	Occupancy Load	UEW Required: stairways @ 113 per UEW	UEW Required: doors @ 150 per UEW
1	10,338	103	1	1
2	9,958	100	1	1
3	11,625	116	1.5	1
4	7,335	73	1	1

Corridors are 56 inches.
Doors to stairway are 36 inches.
Stairways are 44 inches.

Length of Exit Travel

How exits are distributed throughout the building is determined by the *length of exit travel.* To understand how this parameter is measured, we must understand the meanings of and distinctions among the three components of the *means of egress*: *exit access, exit*, and *exit discharge.*

An *exit access* "is that portion of an exitway which leads to an entrance to an exit" (§ 201.1, page 54). The common term for exit access is "corridor." The corridor leads to a stairtower, which if properly enclosed is an *exit*. The door to the stairtower is an "entrance to an exit." A person inside of the stairtower is said to be "in the *exit*." Exits are required to discharge directly to the outside of the building. If not, the path between the exit and the outside of the building is called a "grade exit passageway" (§ 611.0). The path between an exit and a public way is called the "exit discharge."

Table 607 establishes maximum lengths of exit travel, which vary according to the use group and whether or not the building is suppressed. If the path of travel from any point in a room to the exit access is greater than 50 feet, the length of exit travel is computed between the remotest part of the room and the exit (stairtower). If the path of travel from the remotest part of the room to the exit access door (the door to the corridor) is less than 50 feet, the maximum length of exit travel is computed between the exit access door and the exit (that is, the distance from the corridor door to the stairtower door). The vertical descent (within the exit) is not included in this measurement.

Not all exit arrangements have corridors. For example, for a large open warehouse that simply has doors to the outside we would have difficulty identifying the three components of means of egress. In this case the *exit*

access would be the path of travel to the door to the outside, the *exit* would be the door to the outside, and the *exit discharge* would be the sidewalk from the exit door to the public way.

Configuration

How exits are distributed throughout the building is determined by the *length of exit travel.* As explained above, section 607.4 limits the length of travel to the distances specified in Table 607. Distances are based on *occupancy* and whether *suppression* is provided.

Exit access corridors are required to provide a choice of two directions in which to travel, each of which leads to an exit. Corridors that do not provide two alternatives are called "dead end corridors." Dead end sections of corridors are limited to 20 feet in length (§ 610.2). In *health care facilities*, "dead end" corridors are limited to 30 feet (see § 433.0 and NFiPA 101 [1976] § 10.2.2.5.7).

Protection of Egress Passageways

Corridors are required to have a *fire resistance rating* of at least 1 hour and any openings therein must contain *opening protectives* (§ 610.4). Glass panels within these walls are required to be of at least ¼-inch wired glass in approved metal frames and limited to 1,296 square inches in area (§ 610.4.1 and § 917). Doors in corridor walls are required to bear a fire resistance rating of .75 hours or may be of 1¾-inch solid bonded core wood (Table 915). Doors that are a part of a required fire-resistive assembly should be kept *normally closed* and may be held open only with approved magnetic *hold open devices,* which close automatically upon the loss of power or upon the activation of an *alarm condition* by the suppression or detection equipment (§ 915). In buildings equipped with an automatic fire suppression system, corridors are not required to have a fire-resistance rating or opening protectives (§ 610.4).

Stairways are required to be enclosed in construction with a 2 hour fire resistance rating (§ 616.9.2 and Table 214).

Interior Finish

Class 1 or 2 *flame spread* ratings are required on interior finish materials in corridors and stairwells. Other rooms or enclosed spaces are required to have Class 3 or better. (It might be noted that Class 1 flame spread can be achieved on a wood finish material with the application of an "intumescent" (fire-retardant) paint or shellac (Table 920).

Smoke Control

Section 612.2 requires that classrooms used for instructional purposes with an occupancy load of ten or more children under the age of twelve must provide two independent means of egress, arranged such that to reach one egress, it will not be necessary to pass through a corridor or passageway that is connected with the other egress unless that corridor or passageway is divided with a smoke barrier (cross-corridor doors). Passage to either side of the smoke barrier can be effected through communicating doors that connect the classrooms.

In buildings over six stories or 75 feet in height that are classified in Use Groups A-2, A-3, A-4, A-5, B, F, I, M, or R-1, Section 618.0 states that one of the required exitways must be a smokeproof enclosure.

Hardware

Section 612.5.1 requires that doors used for egress must be readily openable from the side occupied with a simple motion that is obvious even in darkness. Draw bolts, hooks, and similar devices are prohibited. Double cylinder deadbolts are prohibited except in single dwelling units.

§ 612.5.1.1 references MGL Chapter 143 §3R, which requires that *residential occupancies* with four or more dwelling units be equipped with a locking device, an automatic closing device, an electrically operated striker, and associated equipment.

§ 612.5.2 requires *panic hardware* in *assembly occupancies*.

§ 612.5.3 and 612.5.1 allow approved *time-release locking mechanisms* in *institutional occupancies*.

§ 612.5.4 requires that doors to an exitway or smoke barrier be *normally closed*. If kept open, they must close upon the activation of fire detection, the activation of suppression, or the loss of power. Powered doors must be operable upon the loss of power with not more than 50 pounds of pressure. Nonpowered devices must yield with the application of not more than 15 pounds of pressure.

Illumination and Signage

Buildings with an occupancy load of fifty persons or more are required to be equipped with internally illuminated exit signs (§ 623), and places of assembly are required to provide artificial lighting in the means of egress

(§ 624). Emergency power is to be supplied for both the signage and the lighting.

Dimensioning of Stairs

The basic dimensional requirements for stairways are found in section 616.2 through section 616.7, which govern *interior exitway stairways*. The same dimensions apply to all other stairways that are used as exits (see § 619.1.1 exterior exitway stairways and § 620.1 moving exitway stairways).

§ 616.2.1 specifies a *minimum width* of 44 inches where the *occupancy load* exceeds fifty persons and 36 inches with an occupancy load of less than fifty.

§ 616.2.2 requires a *minimum headroom clearance* of 6 feet 8 inches.

§ 616.2.3 limits *projections* into the stairway (excluding handrails) to 1.5 inches.

§ 616.3.1 requires that *landings* measure at least the required width of the stairway. This applies to both the length and the width of the landing.

§ 616.3.2 prohibits a stairway to *rise* more than 12 feet without a landing.

§ 616.4.1 gives the minimum dimensional requirements for *treads* and *risers* in inches. These requirements vary according to occupancy:

Use Group	Risers (maximum height)	Treads (minimum width)
Assembly and institutional	7.50	10
One- and two-family dwellings	8.25	9
All others	8.00	9

Heed the *fine print*:
NOTE 1: Within any flight, the variation in risers shall not exceed 3/16 inch.
NOTE 2: Except for one- and two-family dwellings, 2 *risers* + 1 *tread* must measure between 24 and 25 inches (nosing excluded).

§ 616.5 requires *stairway guards* and *handrails* on both sides of stairways. In stairways wider than 88 inches, intermediate guards must be supplied.

§ 616.5.1 supplies *handrail details*. They should be between 30 inches and 34 inches high and not project into the stairway more than 3.25 inches. They should extend beyond each flight for 18 inches and return to the wall. They should withstand 200 pounds of pressure applied at any point in any direction.

§ 616.5.2 supplies *guard details*. Guards should be at least 42 inches in height. This requirement is reduced to 30 inches in stairs that do not exceed 20 feet in height and do reverse direction at landings. Guards must be fitted with a *balustrade* or other ornamental fittings configured so as to prevent the passing through of a 6-inch sphere. Guards measuring 42 inches in height must be supplied along *open sided* floor areas, mezzanines, and landings (36-inch guards in one- and two-family dwellings).

§ 616.6.1 requires that *doors to a stairway* measure at least 32 inches in width (28 inches in one- and two-family dwellings).

§ 616.6.3 prohibits a door from *penetrating the landing* in excess of half of its required width. When fully opened, the door should project no more than 7 inches into the landing.

§ 616.7 allows *spiral stairways* in a means of egress in one- and two-family dwellings and mezzanines that measure up to 250 square feet with an occupancy not exceeding five persons. The spiral stairway must be at least 26 inches in width with *treads* measuring at least 7.5 inches in width at 12 inches from the narrow end and *risers* not exceeding 9.5 inches. Headroom must measure at least 6 feet 6 inches.

§ 616.7.1 allows *circular stairways* in a means of egress when the minimum tread width is 10 inches and the smaller radius is not more than twice the width of the stairway.

§ 616.4.2 addresses *winders*, which are allowed only in one- and two-family dwellings or as ornamental stairways that are not required for egress. Where used, the winders must not be narrower than 6 inches at any point. They must measure at least 9 inches in tread width at 12 inches from the narrow end (the numbers are slightly different in § 2101.10.8.3).

Evacuation Planning

In addition to the provision of properly dimensioned and protected egress passages, there are requirements that bear on the capability of the popula-

tion to evacuate the building in a timely manner. Some of these are "operational" as opposed to "physical" in nature. Routine and periodic fire drills and comprehensible maintenance recordkeeping, are examples of "operational" requirements, as is the provision of clear, concise, and easy-to-follow exit maps.

ARCHITECTURAL BARRIERS BOARD REGULATIONS: A WORD ABOUT THE HANDICAPPED

Ask any marathon runner what the course record for the Boston Marathon is today. Chances are you'll get the wrong answer. Rob deCastella holds the record for males under forty at 2:07:51. The wheelchair record, however, was set on April 16, 1990, by Moussetapha Badid at 1:29:53—more than one-half hour faster!

The remarkable athletes who compete in wheelchairs inspire an admiration for their stamina. The powerful musculature in their upper bodies more than compensates for the lack of strength in their legs.

A friend, a dancing instructor, wrote to me of Bhaskar, a dancer who fell from the stage in his native India and was crippled from the waist down thereafter. This did not end his dancing career, instead, he continued to perform adjusting his style around a new set of constraints. She saw him perform in New York City one year and described his performance in the following words:

> He glided onto the stage with a dancers poise; his wheelchair was camouflaged by a cotton Indian print skirt. He danced with his arms at first, swaying and stretching to the music. As the performance continued, he seemed to stretch beyond human limits. His arms reached higher and higher, and his body seemed to elongate with each successive beat. As the music approached a crescendo, he seemed to levitate above the surface of the stage, transcending not only his handicap but the very imprisonment of gravity as well.

The point is that our handicapped citizens contribute to our society in many ways. Their achievements should not be minimized. In fact, the author expects remarkable things from this minority population in the years to come. To expedite these achievements, it is useful to consider their needs early in the design phase of our construction projects.

If inviting the physically challenged into our everyday life is not reason enough to design our buildings so as to provide them access, consider this: *everyone* is challenged at some point in their lives. Indeed, the riddle of the sphinx serves to remind those who regard this regulation to be little more than an annoying set of design constraints that no human being is "able-bodied" for the entirety of his or her life. Consequently, we all benefit from

making our buildings accessible. One notices that the ramps of our public buildings are used not only by those confined to wheelchairs, but by the elderly, mothers with children, and even those hearty types who are charged with the task of carrying the heavy furniture and equipment into a building.

The Massachusetts State Building Code devotes only two sections to the issue of accessibility to the physically handicapped. These are found in Section 315 (on page 131).

Section 315.1 requires that buildings or parts of buildings classified in Use Groups A, M, F, I, R-1, and R-2 provide at least one entrance that is usable by a wheelchair and that provides access to elevators if elevators are provided. Section 315.1.1 requires handicapped access in *limited group residences*.

There is an additional set of regulations, however. The Rules and Regulations of the Architectural Barriers Board (521 CMR) provide design specifications for the provision of access to the physically handicapped in public buildings.

Appendix 1

Structures: An Annotated Bibliography

No discussion of a building code is complete without some reference to the structural principles that govern the erection of buildings. Articles 7 and 8 of the code govern the principles of structural design and the use of materials, respectively. Both articles contain references to *accepted engineering practice* and are written with the presumption that the reader has something beyond the layman's familiarity with these subjects. Article 7 addresses the design assumptions underlying structural and foundation loads and gives the designer some direction as to the proper ways to consider them. Article 8 concerns the materials that are commonly used in structures and addresses not only the designer but, in some cases the construction supervisor or the manufacturer of construction materials.

Because there are a number of excellent textbooks covering these subjects, it would not be fitting to attempt to cover all of these subjects in the limited space available in this volume. The following short bibliography identifies some publications that are available to the code reader who would like to pursue an understanding of structures without pursuing professional training. I have selected several of my favorite recommendations. They vary in their depth and range of treatment of the subject. But they have in common the fact that, whenever I have recommended them, they have been very well received.

Fitchen, John. *Building Construction Before Mechanization.* Cambridge, Mass. The MIT Press, 1988. This is a well researched book that discusses the whys and wherefores of building techniques throughout history. Chapter 6 contains an excellent discussion of stresses and their consequent design problems. Chapter 4 contains a brief discussion about codes and factors of safety and also provides a good translation of the relevant sections of the code of Hammurabi. I particularly like this book because it is a hermeneutic of sorts.

Fitzgerald, Robert W. *Strength of Materials*. Reading, Mass. Addison-Wesley Publishing Company, 1967. This is my favorite book, not only because the author was a teacher of mine, but because the style is simple

and straightforward. The appendix contains an excellent review of vector mechanics and a number of useful tables. Computations are clear and neatly arranged, and both calculus-based and noncalculus-based derivations are provided in each section. Chapters are written so that the sequence can be varied.

Gordon, J. E. *Structures*. New York: Da Capo Press, 1978; *The New Science of Strong Materials*. Princeton, N.J.: Princeton University Press, 1968; *The Science of Structures and Materials*. New York: Scientific American Books Inc., 1988. These three books by J. E. Gordon are among the most readable available. Professor Gordon's sense of history and talent for storytelling give an entrée to the science of structures to the reader who would rather be reading novels. The most recent of these books is from the Scientific American Library Series. It is more expensive than the rest, but the graphics are exquisite.

Huntington, Whitney Clark. *Building Construction*. New York: John Wiley and Sons, Inc., 1963. This classic is not about structural mechanics; it is about building. It is a nut-and-bolts description of modern construction in a very readable form with good illustrations. My personal favorite is the third edition.

Jenson, Alfred, and Chenoweth, Harry H. *Applied Engineering Mechanics*. New York: McGraw-Hill Book Company, 1972. This is a very popular textbook that I often recommend to building inspectors. As with Dr. Fitzgerald's book, previously mentioned, this textbook provides a treatment that can be followed by students who have completed their calculus sequence as well as those who have not. Professor Jensen has, over the years, been a significant force in the code writing community.

Salvadori, Mario. *The Art of Construction*. Chicago: Chicago Review Press, 1990; *Why Buildings Stand Up*. New York: W. W. Norton & Company, 1980; Salvadori, Mario, and Heller, Robert. *Structure in Architecture*. Englewood Cliffs, NJ: Prentice Hall, 1986. Salvadori, Mario, and Levy, Matthys. *Structural Design in Architecture*. Englewood Cliffs, N.J.: Prentice Hall, 1967. Professor Salvadori's books are popular among architects. They are arranged here in order of progressive difficulty. The first is a children's book that should be of interest to anyone seeking a good intuitive sense of the principles of structures. The second, which was written for a general audience, is perhaps the most popular of its kind. Nearly every architect I have worked with has a copy. The third, which was written for the architectural student, is a sound, but nonmathematical treatment of structures, loads, structural members, and the phenomena of structural failure. The fourth is a textbook that was written for the undergraduate student of architecture or engineering and provides an excellent arrangement of solved problems.

Schodek, Daniel L. *Structures*. Englewood Cliffs, N.J.: Prentice Hall, 1980. This fine textbook emphasizes the geometrical form of structures and structural units. Although it is not without mathematical rigor, its expressed intent is a qualitative or intuitive approach to structural design. I have frequently allowed students and design professionals with whom I work to borrow this book. I've never had it returned without a struggle.

Wing, Charles, and Cole, John. *Breaking New Ground*. Boston: Atlantic Monthly Press, 1986. For the builder of the single-family detached wood frame dwelling, this book is one of the most helpful and the most readable. It takes the form of a series of letters between two friends—one a home builder, the other a physicist. It is an excellent discussion of the rationale behind the building code requirements for small buildings.

Appendix 2
Plan Review

Code requirements are not the same for all buildings. Many requirements are contingent on the *construction type* and *occupancy classification* of the building being reviewed. These must be given before any plan review is undertaken.

Construction Type

This represents the construction type classification as defined in Section 214 of the Massachusetts State Building Code, and the *fire resistance ratings* as enumerated in Table 214.

Occupancy Classification

This represents the *occupancy use group classification* or as specified in Section 202 of the code.

The plan reviewer's first task is to determine that the *height* and the *area* of the building are within the limitations set by Table 305. In order to do this, information on basic dimensional data and basic compliance data must be provided.

Basic Dimensional Data

Footprint Area

This figure represents the area of the building's "footprint," that is, the area of the building as viewed from a helicopter. If floor areas are irregular, the *largest floor area* should be used.

Total Floor Area

Many buildings exceed one story in height. If all floor areas are identical, this figure can be obtained by multiplying the footprint area by the number

of stories. If there are stories above or below grade that occupy less than the full footprint area, the sum of the areas will be used.

Footprint area, therefore, should not be confused with *total floor area.* The area limitations specified in Table 305 refer to the footprint area.

Height

Height is the vertical distance from the grade to the top of the highest roof beams, or to the mean level of the highest gable (§ 201). The tabular height limitations enumerated in Table 305 of the code apply to this meaning of "height." It is well to remember that the code defines *first story* as the "lowermost story entirely above the grade plane" (§ 201) and distinguishes *story* from *cellar* or *basement*. In many buildings, there is "habitable" space located in basements and cellars.

Basic Compliance Data

Tabular Height

This figure represents the height limitations established by Table 305 of the code. Tabular height is a function of the *construction type* and the *occupancy*. It is well to remember that these limitations are not absolute but are modified by subsequent sections of the code, which give further allowances for suppression systems.

Tabular Area

This figure represents the footprint area limitations established by Table 305 of the code. Tabular area is a function of the *construction type* and the *occupancy*. As with *tabular height*, the *tabular area* is not an absolute parameter, but is modified by subsequent sections of the code, which provide increases as a "trade-off" for suppression systems and/or accessibility for the Fire Service.

Suppression

This parameter indicates the existence of suppression systems. "Full Suppression" of the facility means that the system is installed in accordance with the provisions of NFPA 13.

EXAMPLE

The proposed building is a four-story office building located at XXXXXXX Road in XXXXXXXX XX. (MAP # XX, LOT # XX)

Construction type: 2C construction
Occupancy: business, Use Group B
Hazard index: 2
Footprint area: 11,625 square feet (largest floor area)
Height: four stories
Suppression: full suppression per NFPA 13

Height: Table 305 allows three stories or 40 feet in height.

ADJUSTMENTS: § 308.0 allows an increase of one story or 20 feet in height for full suppression.

Area: Table 305 allows an area of 14,400 square feet.

ADJUSTMENTS:

Tabular Area is 14,400 (Table 305).

Adjusted Tabular Area Table 305.4 requires a 20 percent reduction in area for a four-story building of Type 2C construction. (14,400 × .8 = 11,520)

Area Increases

1. § 306.3 allows an increase of 100 percent in area for full suppression. (area increase equals 11,520 square feet)

2. § 306.2 allows an increase of 2 percent in area for each 1 percent of excess frontage. Frontage is defined as 30 feet of unoccupied space accessible from a public way. (area increase equals 17,280 square feet)

3. Per § 306.5 the *total area* cannot exceed 3.5 times the *tabular area* (11,520 × 3.5 = 34,560)

Bottom Line: building is Type 2C construction; allowable height is four stories; allowable area is 34,560 square feet; actual height is four stories; actual area is 11,625 square feet.

Occupancy Load and Egress Calculations:

1. Table 606 gives maximum floor area per occupant for a business occupancy, at 100 square feet/person.
2. Table 608 gives capacity per UEW for *suppressed* buildings of *business occupancy* at 113 for *stairways* and 150 for *doors, ramps,* and *corridors*

Floor areas and occupancy loads are as follows:

Floor Number	Floor Area (in square feet)	Occupancy Load	UEW Required *stairways* @ 113 per UEW	UEW Required *doors* @ 150 per UEW
1	10,338	103	1	1
2	9,958	100	1	1
3	11,625	116	1.5	1
4	7,335	73	1	1

Corridors are 56 inches
Doors to Stairway are 36 inches
Stairways are 44 inches

List any special occupancies or features:

For example:

(3) High Rise Building, or
(3) Unlimited Area Building, or
(3) Atrium Center of Structure, or
(3) Windowless Building

Appendix 3

A Few Hints on Reading Tables

1. *Read the Heading*. This should indicate the *table number* and *title*.
   a. *Note the table number*. Frequently this corresponds to a *section number* in the text of the code. For example: Table 305 (page 122), corresponds to Section 305 (page 121).
   b. *Note the heading*. This indicates the *subject* of the table. Usually this means the *answer* that you seek. *Height* and *area limitations* is the subject of Table 305.
2. *Read the fine print*. The notes contain exceptions and modifications of the *tabular* information. To ignore them is to display naïveté.
3. *Note the parameters*. Column and row headings contain parameters. This is the information that you bring to the table. The parameters are the gazintas—the answers are the gozoutas. In Table 305, *construction type* and *occupancy* are the gazintas. *Maximum allowable height* and *area* are the gazoutas.
   a. Note the column headings.
   b. Note the stub.
   c. Note the row headings.
   d. Note any subdivisions in columns or rows.
4. *Some important tables*: 214, 305, 606, 607, 608, 720, 920, 1000, 1110.1.2, 1203, 1216, 2009.1.
   From Article 21: 2102.1, 2103–2, 2103–3, 2108-all, 2104–7, 2105-both, 2105–3, 2105–6, 2106-all, 2107–11, 2110–1, 2123–1.
   From the Appendix: appendix J-all, appendix M, appendix T, Table T-1.

READING THE FRAMING TABLES

It is hard to conceive that the framing of a single-family house could involve any structural calculations that have not already been computed. The structural components of a building of this scale have been examined and computed for nearly every configuration and every material.

Since most houses are built of wood, the design data that will prove to be most useful has been published by the National Forest Products Associ-

ation. The publication entitled "Wood Structural Design Data" provides basic information concerning the properties of structural lumber, the design of beams and columns, the design of plank and laminated floors and roofs, and calculations for determining maximum spans for joisting.

The building code, provides this kind of information; in fact, it supplies additional useful information as well. We know that the important parameters for the design of joists and rafters will be contingent on the kind of wood that we intend to use. If we know the *species* and the *grade* of the lumber, it is possible to find the *modulus of elasticity* (E) and the *maximum allowable stress in bending* (Fb). These are found in Table 2108. Actually this section consists of five tables designated by the number 2108 and the letters A to E. (They are found on pages 578-582.)

The title of table 2108 is "Design Values for Joists and Rafters-Visual Grading". The fine print below says "These (Fb) values are for where repetitive members are spaced not more than 24 inches. For wider spacing, the Fb values should be reduced 13 percent." No problem, most framing is done at 16 inches on center. Some is done at 24 inches on center. Any other configuration of framing should cause the building inspector to look at these calculations with more than usual caution.

The fine print goes on to say, "Values for surfaced dry and surfaced green apply at 19 percent maximum moisture content in use." At one time the tables would assign different values to lumber depending on whether the lumber was "surfaced" (planed) before or after it was dried. A few years before that (say around the years when most three deckers were built—1860–1928) framing lumber was not surfaced. Also in those days it was apparently unnecessary to distinguish between "nominal" dimensions (the dimensions in "law") and "actual" dimensions (the dimensions in "fact") and to a large extent the practice of surface planing lumber can be said to account for the fact that a "two-by-four ain't a two-by-four no more." Actually it's a 1¾ by 3½.

What has the table told us so far? that these are design values; that they are for joists and rafters; that this wood has been visually graded; that they are for "conventional framing" (not more than 24 inches on center) that they apply at 19 percent maximum mosture content (where designated).

Look at the column headings. The first is size, everything seems to be for 2 x 5 and wider. We are to suspect 2 x 4s if used for rafters and joists.

The next three columns designate the stress in bending for three different conditions: *normal duration, snow loading,* and *seven day loading*. We will mostly be concerned with *normal duration*. But let's take a moment to look at the other two.

Snow isn't on the roof at all times, even in New England—although it may snow at any time. (If New England weather provides anything it provides relief.) The table allows us to assume a higher "stiffness" for calculating the capacity of this wood under a temporary *snow load*.

Seven day loading might be used to check to see if it is a good idea to set a load of gypsum wallboard on the second floor for a while. The *stiffness* that we are allowed to assume is even higher than it is for snow loading (but not infinite as some have learned).

For most of our computations, we will use the *stiffness* value (Fb) supplied in the column headed "normal duration."

The last column provides us with the *modulus of elasticity* (E) for each species and grade of lumber. Notice that this ranges between slightly greater than .5 million to nearly 2 million. Remember that this is the ratio of *stress* to *strain* throughout the *range of elasticity*.

SOME EXAMPLES

[Table 2105–6].

What is the maximum column spacing allowed if a 6×12–inch wood girder with a f_b of 1200 psi if the building is 28 feet wide and one story in height with an attic?

a. What strip are we looking at?
b. What block are we looking at?
c. Which line are we looking at?
d. Which column are we looking at?

The building has 2 x 10″ SPF number 2. joists at 16 inches on center.

a. What page are we on?
b. What f_b do we need?
c. What E do we need?
d. Where do we go for the f_b and the E for Spruce Pine Fir?

[Table 2108-D]

e. What block are we in?
f. What line are we on?
g. Which column is f_b?
f. Which column is E?

Appendix 4

Thirty-Five Good Questions and Where to Find the Answers

The following questions have been strategically selected to represent questions that are frequently asked, or questions with particularly enlightening answers. Some have circulated the building inspectors training seminars as "bar bets." Many of these challenges have underwritten the author's bar bill.

There are two answers to each question. The first designates the article that contains the answer and the second gives the page number and the section, table, or illustration that contains the answer. Finding the appropriate section for these issues requires some basic skill in the use of the code as well as a fundamental understanding of the structure of the code.

1. What is the minimum sill size for a raised ranch?
   article 21 one- and two-family dwellings
   § 2103.2.3 wall construction (page 561) refers to Figure 2103–3, (page 569)

2. What are the design requirements for a paint spray booth?
   article 4 special occupancies
   § 411.0 paint spray booths, (pages 148–49)

3. What are the ceiling height requirements for habitable rooms?
   article 5 light, ventilation, and sound transmission control
   § 506.5 room dimensions, (pages 202–3)

4. What fire resistance rating is needed for a door in a 2-hour wall assembly?
   article 9 fire-resistive construction requirements
   § 915 fire doors; Table 915 fire door resistance ratings, (page 388)

5. Where are sprinkler systems required?
   article 12 fire protection systems
   § 1202 fire suppression systems
   § 1202.1–1202.19, where required, (pages 427–31)

6. What is the maximum allowable extreme stress in bending (F_b) for spruce-pine-fir?
   article 21 one- and two-family dwellings
   § 2105.0 floors (page 592) § 2105.2.3 allowable spans,
   refers to span tables on pages 596–99;
   design values are found in Tables 2108-A and the following
   (pages 578–583)

7. What are the requirements for rear yard setback?
   article 5 light, ventilation, and sound transmission control
   § 517.0 rear yards (page 208)

8. What is the weight of a cubic foot of concrete?
   appendix J unit dead loads for design purposes (page 729)

9. What is the maximum floor area allowed for a mezzanine?
   article 2 definitions (page 64)

10. How do you determine whether a fish processing plant should be considered more hazardous than a dressmakers shop?
    appendix T, part 3 detailed classification of
    occupancy by hazard index number and use group
    (pages 835–835.8)

11. What are the requirements for an unlimited area building?
    article 3 general building limitations
    § 307 unlimited areas (pages 124–26)

12. What are the requirements for fire alarm systems?
    article 12 fire protection systems
    § 1216 automatic fire alarm systems
    § 1216.3 where required (pages 445–50)

13. What are the requirements for the grading of lots following demolition?
    article 13 precautions during construction operations
    § 1308 regulation of lots (page 459)

14. What clearances are required for an awning?
    article 3 general building limitations
    § 310.8 awnings § 310.9 awning boxes and covers (page 128)
    § 313 awnings and canopies (pages 130–31)

15. What are the requirements for the licensing of construction supervisors?
    article 1 administration and enforcement
    § 109.1.1 licensing of construction supervisors
    appendix Q con sup (pages 810.1–810.8)

16. How do you ascertain the fire resistance rating of a floor/ceiling assembly in an existing building?
appendix T part 4 archaic construction systems (pages 835.8–856)

17. When is a building permit required?
article 1 administration and enforcement
§ 113 application for a building permit (pages 14–17);
see also chapter 2 definitions, "repairs, ordinary" (page 71)

18. What are the requirements for the construction of covered malls?
article 4 special occupancies
§ 432.0 covered malls (pages 184–88)

19. How do you estimate live loads for any building?
article 7 structural loads, foundation loads, and stresses
§ 706 uniformly distributed live loads (pages 243–45)

20. How do you determine flame spread requirements for all occupancies?
article 9 fire-resistive construction requirements
§ 920.0 interior wall and ceiling finishes (pages 394–97)
Table 920 (page 396)

21. What are the requirements for wood frame construction in other than a one- and two-family dwelling?
article 8 materials and tests
§ 854 wood frame construction (pages 347–51)

22. What structural loads are assumed in the design of one- and two-family dwellings?
article 21 one and two family dwellings
§ 2101 building planning (page 544)
§ 2101.2 design criteria (page 545)

23. What are the dimensional requirements for stairs?
article 6 means of egress
§ 616.0 interior exitway stairways (pages 227–32)
see also § 619.0 exterior exitway stairways (page 236), which refers to § 616.0; see also § 2102.10.4–2101.11.2 (pages 549–52) for requirements in one- and two-family dwellings

24. What details are required on plans and specifications when submitted with permit application?
article 1 administration and enforcement
§ 113.4 description of work (page 15)
Note: see also the 01 section of chapters with substantive provisions requiring details, for example,
§ 501 (page 200), § 601 (page 213), § 901 (page 371),
§ 1001 (page 407), § 1101 (page 414), § 1201 (page 426),
§ 1301 (page 454), § 1401 (page 466), § 2003 (page 491)

25. How do you locate the frost line for placement of footings?
article 7 structural loads, foundation loads, and stresses
§ 724 depth of footings (page 298)

26. What is the required accessibility for the physically handicapped?
article 3 general building limitations
§ 315 accessibility for the physically handicapped (page 131)
see also appendix P specialized Massachusetts rules and regulations promulgated by agencies other than the state building code commission (pages 754–57) for reference to Rules and Regulations of the Architectural Barriers Board (521 CMR 3.00)

27. What are the safety glazing requirements?
article 8 materials and tests
§ 857.5.6 human impact loads (page 357)
see also article 21 § 2101.7 glazing (pages 547–48)

28. What are the recommended nailing schedules for structural wood framing?
appendix M recommended nailing schedule (pages 742–44)
see also Table 2103–2 fastener schedule for structural members (pages 572–73)

29. Where and how can you use second hand brick in new construction?
article 8 materials and tests
§ 805 brick units (pages 324–25)

30. What are the specifications for a pole foundation for a one- and two-family dwelling?
article 21 reference standards
pole building design (page 679)

31. What are the specifications for crawl space ventilation?
article 5 light, ventilation, and sound transmission control
§ 507 lighting and venting of special spaces (pages 203–4);
see also § 2102.9 underfloor space ventilation (pages 560–61)

32. What are allowable working load deflections?
article 8 materials and tests
§ 803 conditions of acceptance (pages 323–24)
§ 803.3 working load deflections (page 323)

33. What are the requirements for design by a registered architect or engineer?
article 1 administration and enforcement
§ 127 construction control (pages 33–35)

34. What are the requirements for testing of subsurface soil conditions?
    article 8 materials and tests
    § 721 subsurface explorations (pages 294–95)

35. What insulation is required for residential buildings?
    article 20 energy conservation
    § 2009.0 exterior envelope requirements (pages 495–97)
    Table 2009.1 (page 496); see also Figure 2123–1 (page 672) for one- and two-family dwellings

Appendix 5

A Tabbing Index

Epilogue

On September 14, 1990, the Massachusetts Register published a *fifth edition* of the Massachusetts State Building Code, which became effective on that date. The May 1, 1990 version of the *fourth edition* will be concurrently in effect until February 28, 1991. Designers may use either code during this period.

Because codes continually change, there is a sense of futility that accompanies any attempt to identify and explain a code's provisions. But each revision can add but a small increment to its structure, function, rationale, and history. Only the section numbers, page numbers, and details of the provisions exhibit substantial change over time.

This manual was written for the uninitiated reader. Although it uses the *fourth edition* of the Massachusetts State Building Code as its subject, much of it is applicable to subsequent and previous editions, as well as to codes used in other jurisdictions. The conscientious reader of this manual should, with time and practice, develop the ability to navigate the choppy waters of any building code.

Architecture

Hermeneutics is an approach within the fields of philosophy and theology which is concerned with interpretation of text. The word is derived from the name of Hermes Trismegistus and is associated with the secret writings of the Gnostics of the first three centuries A.D. It would be something of an exaggeration to describe the building code as a "secret writing." But, a document with such a wide range of authors, audiences, purposes, and topics can be expected to have obscurities, areas of confusion, arcane legalisms, and scientific jargon, "concealing itself" as J.S. Furnivall once said of the British colonial office, "like a cuttlefish in a cloud of ink."

— from the Introduction

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